$4.00 per Year. DECEMBER 5, 1907. Price 10 Cents.

PUBLIC LIBRARY CITY OF DETROIT

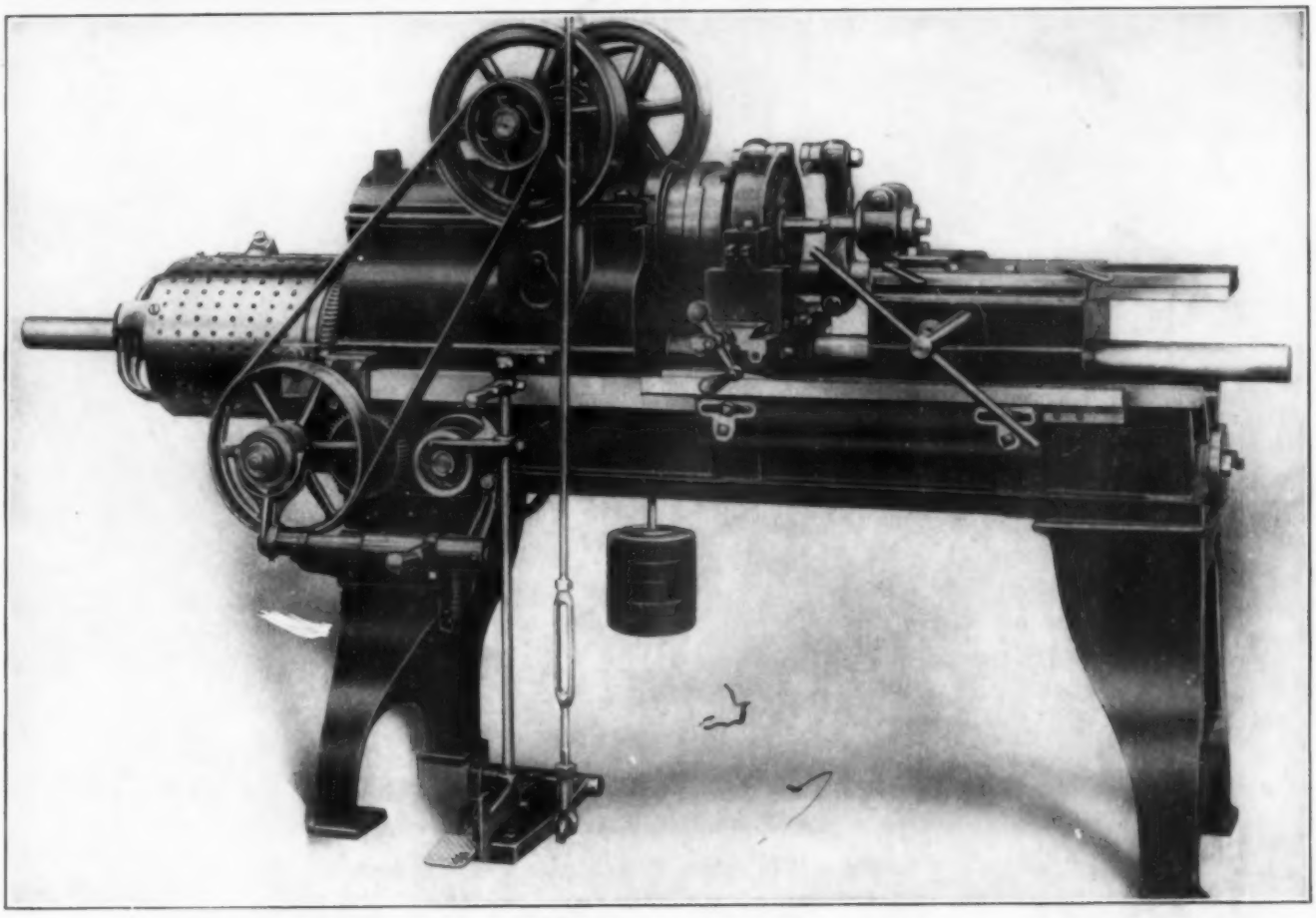
AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY.

Vol. 30. 505 PEARL STREET, NEW YORK. No. 49.

Index to Advertisers and Classified Index Following Reading Matter.



The Fay Automatic Lathe

For Machining Castings, Forgings, Etc., Rapidly And Accurately

On all such work as machining pulleys, sleeves, spur and bevel gear blanks, and other work that can be handled between centers or held in a chuck, this lathe is entirely automatic. Once the work is placed and machine started the various cuts are taken and the lathe stopped with no attention whatever. Perfect uniformity of pieces is certain, in any quantity. Capacity is for work up to 14" dia. over ways, or 10" over carriage, by 10" long.

Write for full particulars.

THE FAY MACHINE TOOL COMPANY,

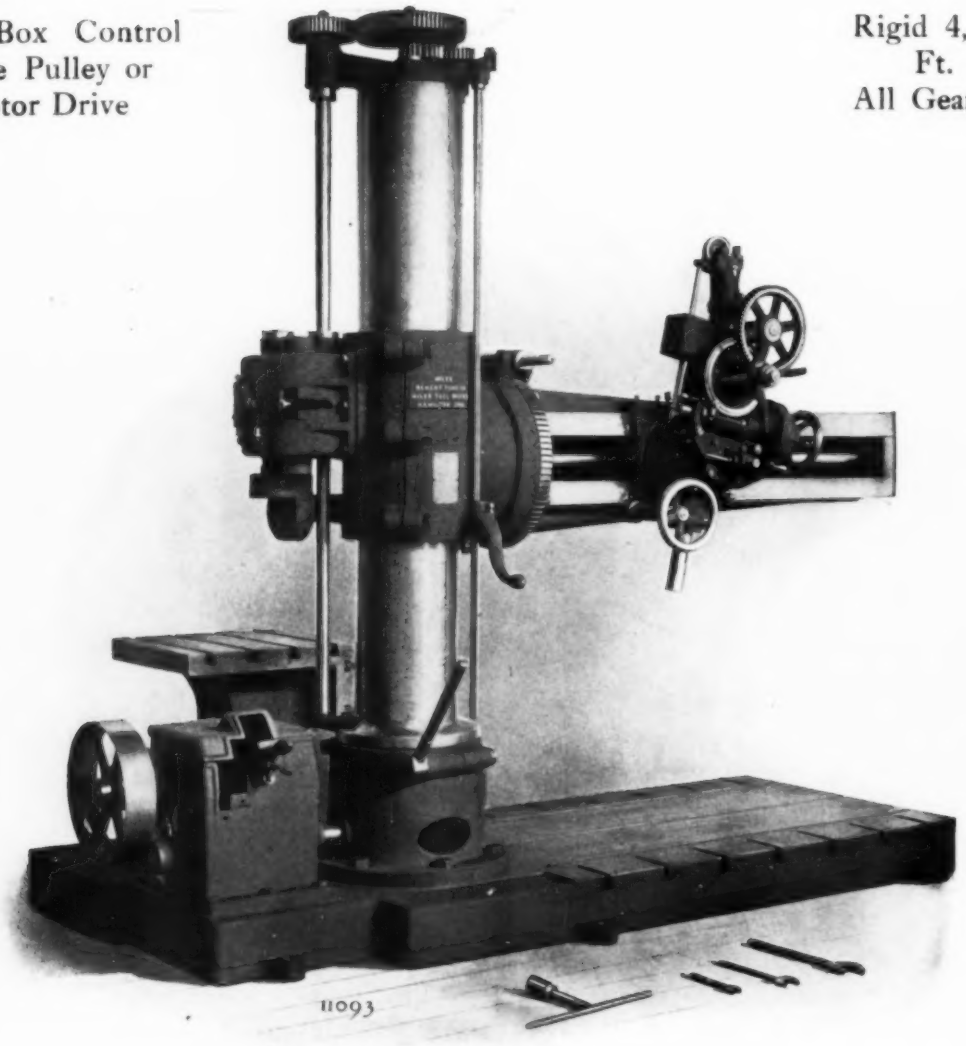
Glenwood Ave., and 2d St., - - PHILADELPHIA, U. S. A.

NILES RADIAL

FOR HIGH SPEED DRILLS

Speed Box Control
Single Pulley or
Motor Drive

Rigid 4, 5 and 6
Ft. Arms
All Geared Head



Niles Radials combine simplicity of construction and convenience of operation with great accuracy and full power at all speeds.

Immediate delivery on some sizes.

NILES-BEMENT-POND COMPANY,

Trinity Building, 111 Broadway, New York, U. S. A.

OFFICES:

Boston: Oliver Bldg. **Chicago**: Commercial National Bank Bldg. **Pittsburg**: Frick Bldg. **St. Louis**: 516 North 3d St. **Philadelphia**: 21st and Callowhill Sts. **Birmingham, Ala**: Brown-Marx Bldg. **Agents**: The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. **Agents for California, Nevada and Arizona**: Harron, Rickard & McCone, 436 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. F. W. Horne, 70 C Yokohama, Japan.

Interesting Operations in a Large Shop

Whereby Parts Large and Small Are Machined with Special Tools, at the Works of the Westinghouse Machine Company

EDITORIAL CORRESPONDENCE

A visit to the machine shop of the plant mentioned in our sub-title shows many interesting special tools and appliances adapted to a wide range of work. It is with pleasure that we are able to show several of these tools, fixtures and special machines, in most cases actually employed upon the operation for which they were designed. In this connection we are pleased to acknowledge the courtesy of Mr. Barton, the manager of works, in furnishing us with every facility for collecting the material for this article. The photographs, which were taken for us, were so clear that a description seems almost unnecessary.

A Boring Bar for Spherical Seats

The first half-tone, Fig. 1, shows a large boring bar, or more properly boring fixture, for spherical seats of engine bearings, in place for boring the main bearings of a 46—86x60 Corliss engine. The two following half-tones, Figs. 2 and 3, show this fixture turned on its side in order that the details may be more plainly seen.

It consists of a heavy cast-iron frame made to rest on the upper planed surface, at the joint of the bearing, and located by angle-iron clips, as shown in Fig. 1. To this frame are bolted bearings which carry the bar. Upon this bar are mounted three boring heads: the two outer ones for cylindrical holes, and the center one for the spherical seat of the bearing. Power is derived from an electric motor and transmitted through the belt wheel, worm and worm gear, which show in all three illustrations, but which perhaps can be best seen in Fig. 1. The middle boring head is pivoted at its center and swings around a block which is fastened to the shaft or bar. Its motion can be taken from either of the end heads. In the illustrations, Figs. 2 and 3, it is shown as connected to the right-hand boring head by means of a link. This fixture is used for boring cylindrical holes 50 inches in diameter and spherical seats 59 inches in diameter. Its cutting speed is about 40 feet per minute, with a 3/32-inch feed for roughing and a ¼-inch feed for finishing. There is a feeding mechanism at each end, which can be operated either by hand or by a star. The method of holding the boring tool needs no description.

A Planing Fixture for Cams

Our fourth half-tone illustration shows a fixture much smaller than the one illustrated by the half-tones which precede it. The part which is being machined is a cast cam for a gas engine, one essential point of which is that the tool marks shall be lengthwise of the face. The illustration is so clear that little explanation is required. The fixture consists of a holder bolted to the planer platen and carrying a pin upon which the casting fulcrums. Near the front of the casting is a stud carrying a roll on each end. These rolls bear upon a cam track or cam bar, which determines the motion of the part and thus of the cam surface. These cam bars are bolted to the housing, and are protected from chips by two sheet-steel guards. It will be readily seen that the weight of the part and the pressure of the tool keep the rolls in contact with the cam-bar surfaces.

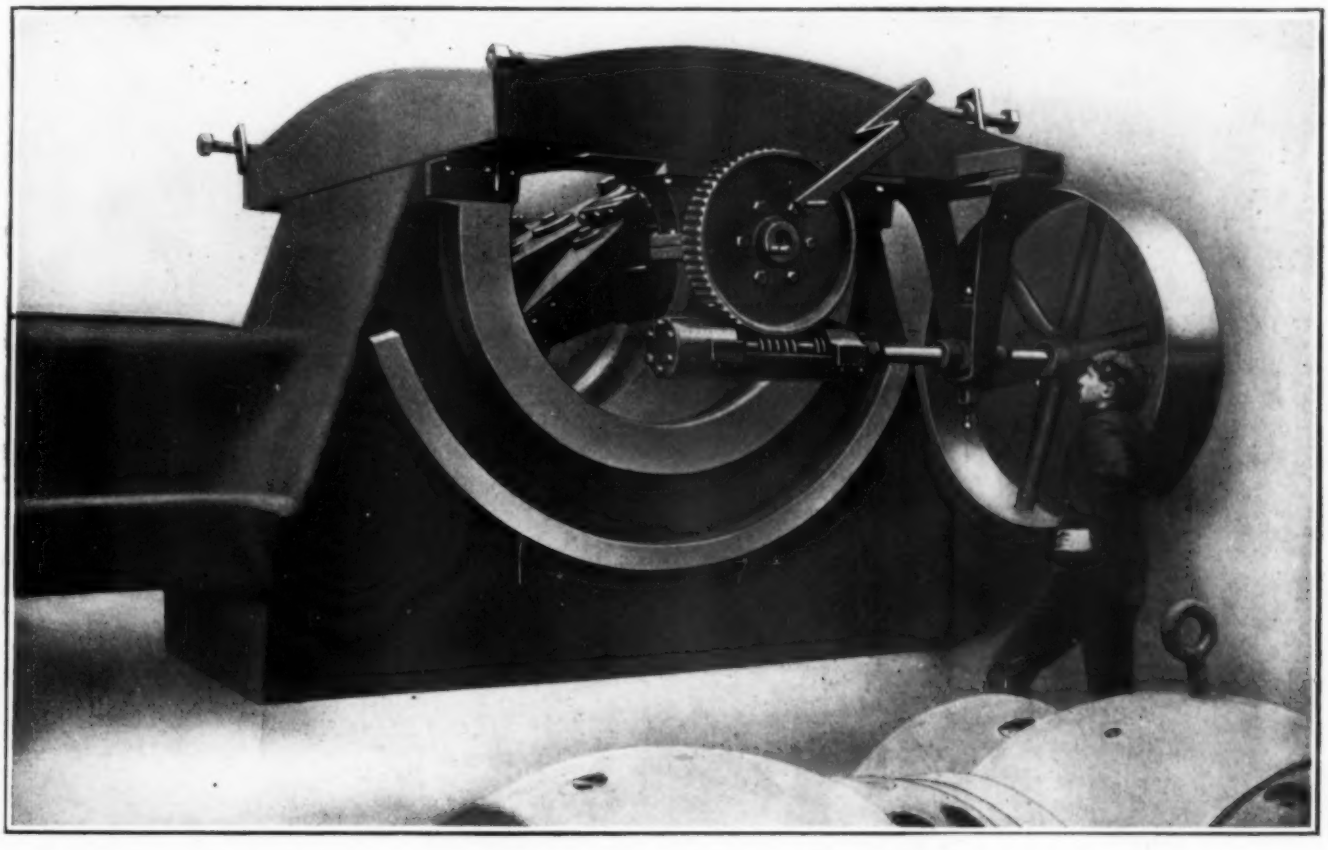


FIG. 1. A LARGE BORING BAR FOR SPHERICAL SEATS

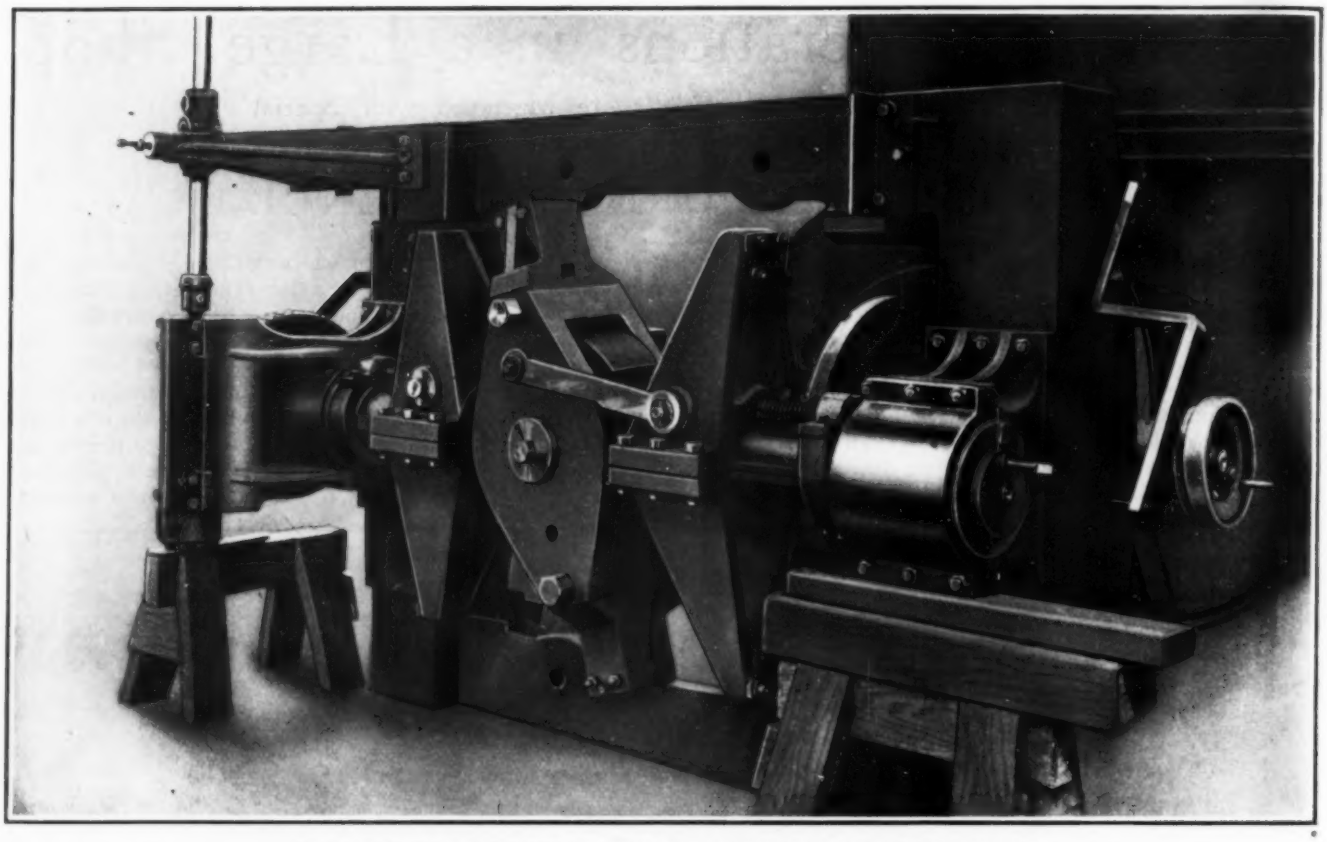


FIG. 2. DETAILS OF THE BAR SHOWING THE HEADS AND FEEDING MECHANISM

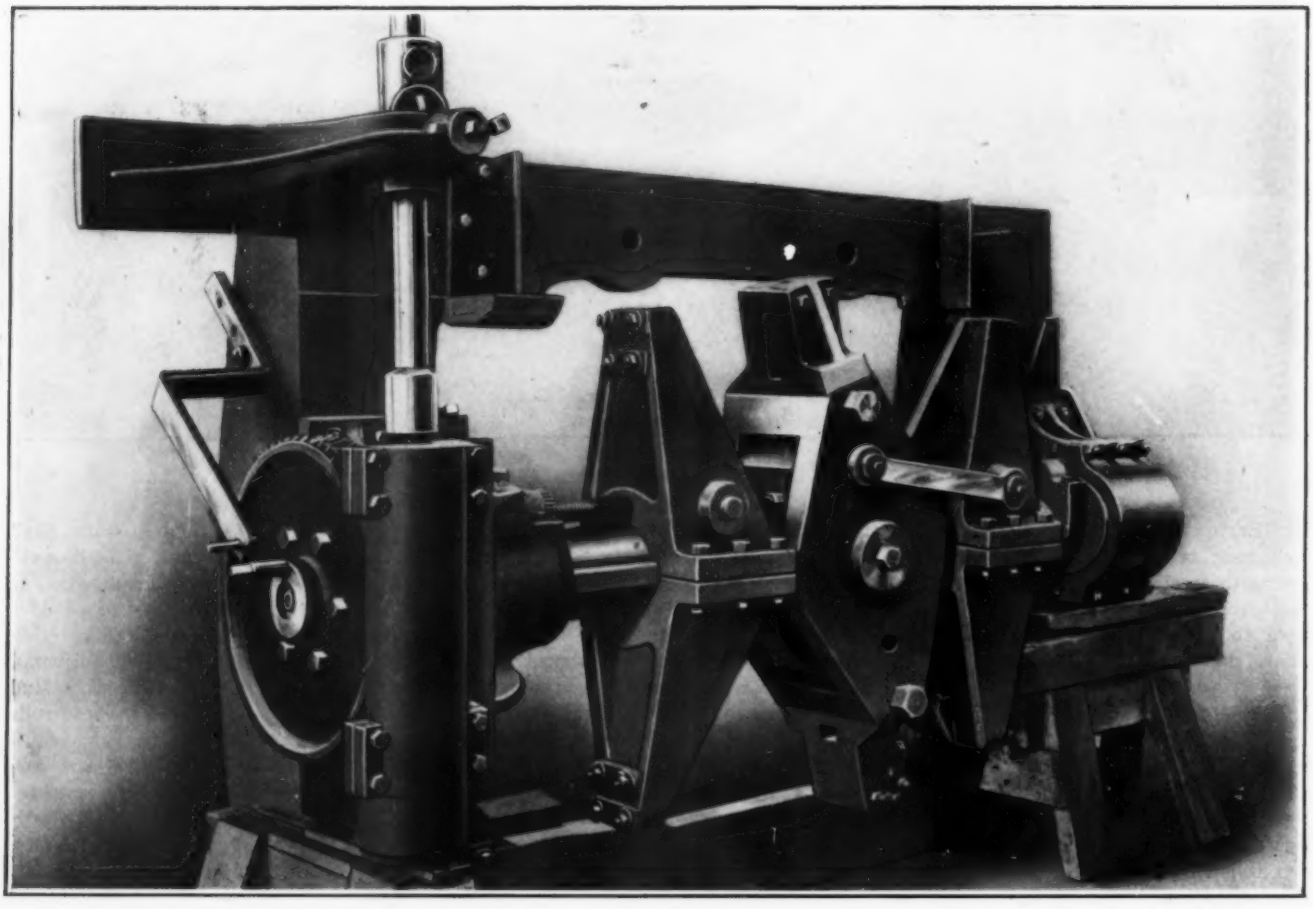


FIG. 3. DETAILS OF THE BAR SHOWING THE DRIVING MECHANISM

A Milling Fixture for Piston-ring Keepers

Our next illustration shows a milling job. The part in the fixture is a small composition casting, a piston-ring keeper for gas engines. The surfaces which are being milled are concave, and this is the feature of the appliance. The casting holder is pivoted on the base block, which is fastened to the miller table and has a bar which enters a guide in the end of the long bracket, which is bolted to the overhanging arm of the machine. The motion of this bar sliding through the guide in the end of the bracket produces a concave surface in the casting being milled with the setting which is shown. A setting can be obtained whereby a convex surface can be milled by this same fixture if desired. A change in the location of the bracket and guide will change the radius of curvature of the surface which is milled.

A Special Cam Grinder

A special machine tool, a grinder for chilled gas-engine cams, is the subject of our illustration, Fig. 6. The work spindle and most of the operating mechanism are carried on a long frame which is fulcrumed at the base of the machine in front. The master cam, or former, and the surface against which it bears are shown at the right of the cupped wheel. A weight inside the column of the machine is attached to the front frame and keeps the former cam in contact with its bearing surface. A rotating motion is transmitted to the spindle through the worm gear and worm, and the worm shaft is in turn driven by a belt from the wheel arbor. A beveled gear situated behind the worm gear furnishes motion to a train of gearing which drives an eccentric at a very slow speed. This eccentric is connected by a rod with the rocker arm shown just at the left of the pilot wheel. This mechanism traverses the cam which is being ground across the face of the wheel. A clutch in the worm gear, operated by a to-and-fro motion of the pilot wheel on its shaft, throws the spindle out of or into engagement with the worm wheel without stopping the machine. The small hand wheel in front operates through gearing and a long screw to give motion to the bar, against which the former bears, and thus adjusts the cam being ground with reference to the face of the wheel or serves as a means of feeding the work against the wheel. The machine is easy to operate and seems very well adapted to the purpose for which it is designed.

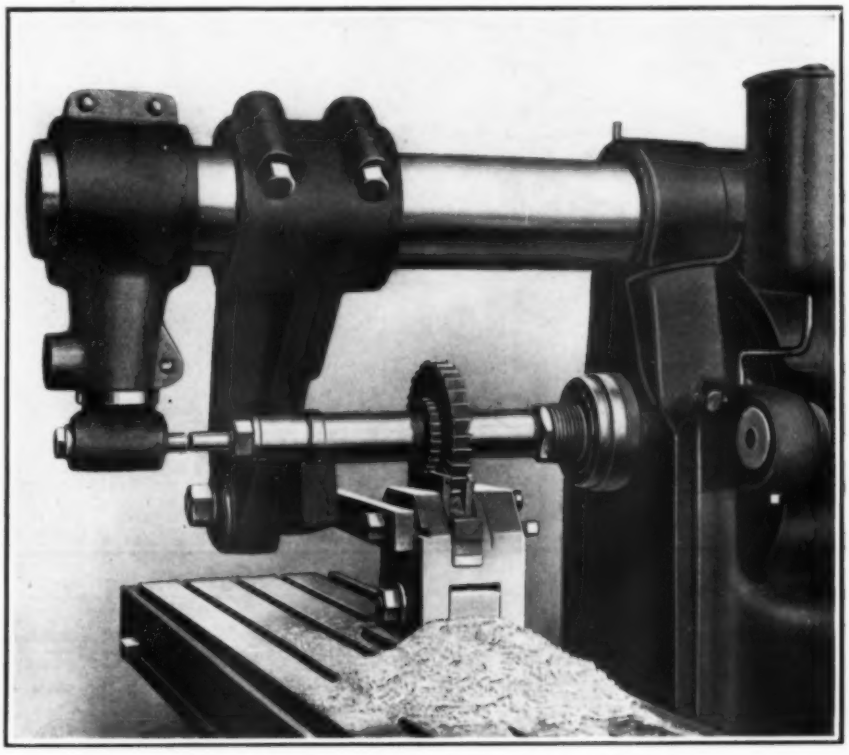


FIG. 5. A FIXTURE FOR MILLING BORING CONCAVE SURFACES

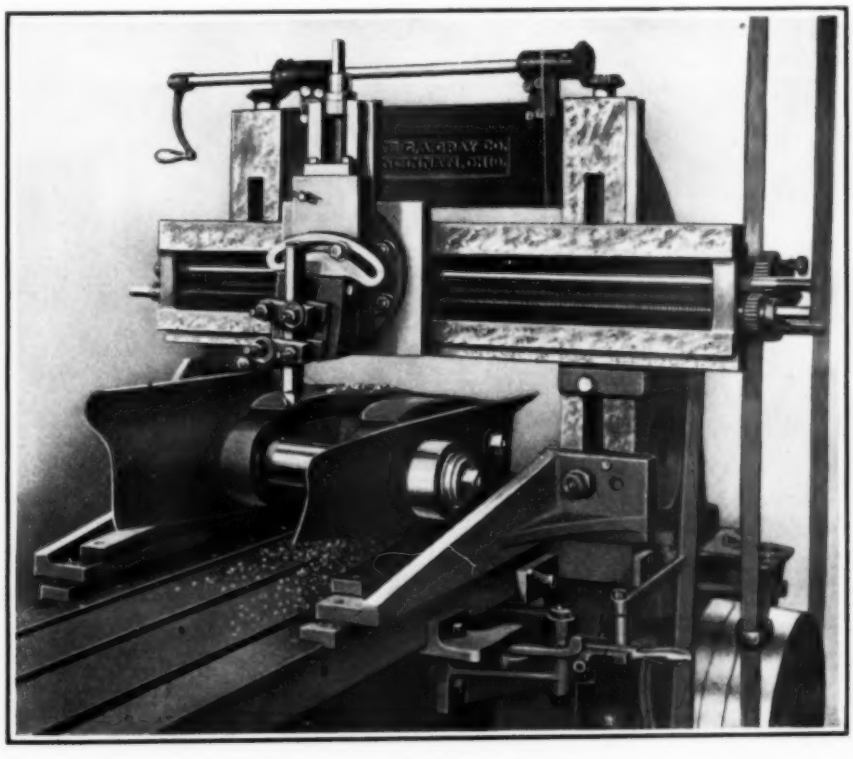


FIG. 4. A CAM-PLANING FIXTURE

A Planer Tool

Another planer device is shown by Figs. 8 and 9. It is a long scraping tool for finishing cuts. The half-tone shows it in position at work on a large casting and the chips which have been removed, but which unfortunately do not show as well in the half-tone reproduction as in the original photograph, give an idea of the work which it does. These tools are used at this plant in a variety of sizes, the line engraving, Fig. 9, having been made from a print of the largest or 10-inch size. The note at the end of the shank "tap for ¾-inch eye bolt" indicates that the weight of this tool is such that the machinist is not expected to handle it with one hand.

A Hollow Mill with Inserted Blades

An interesting job on the radial drill, the boring of 8-inch holes in a turbine spindle with a hollow mill having inserted blades, is shown by our half-tone illustration, Fig. 7. The size of this casting

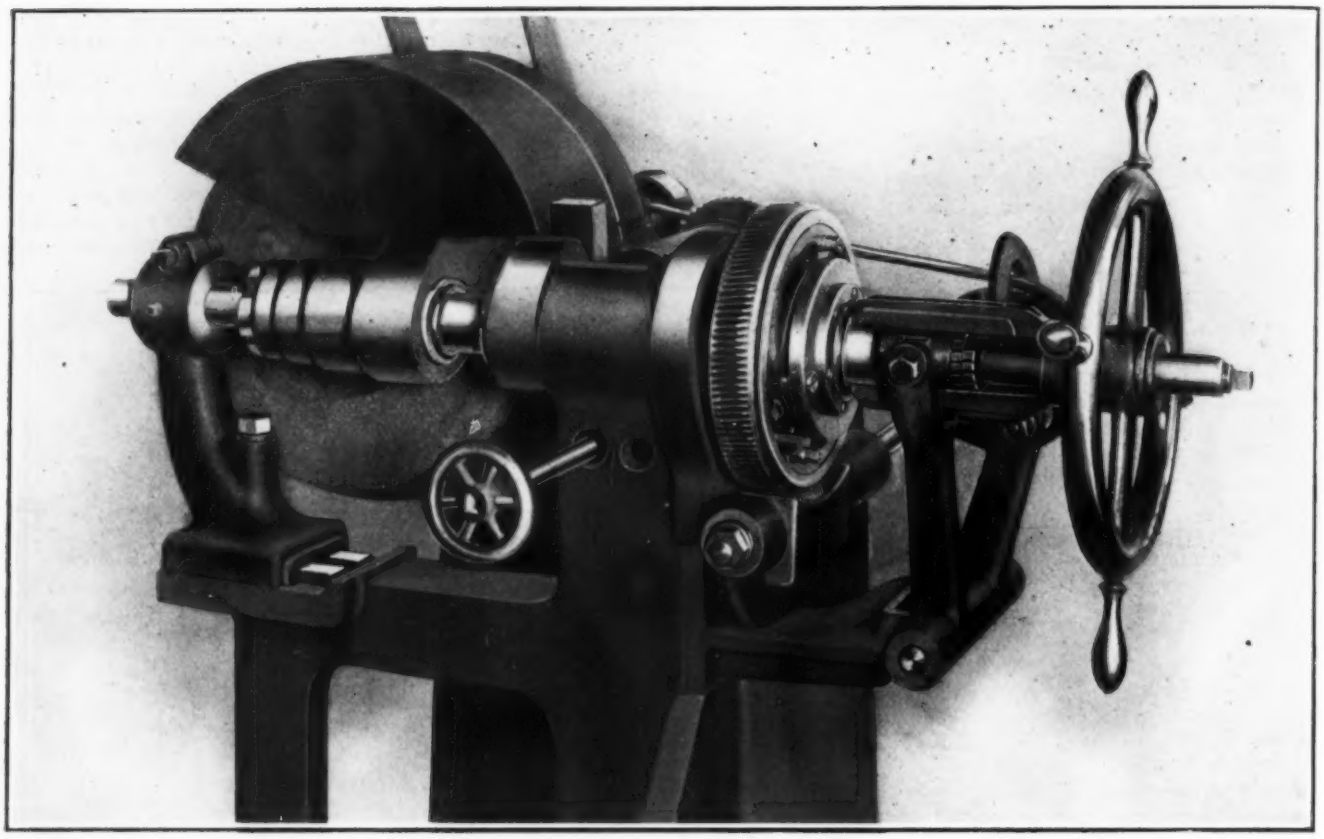


FIG. 6. A SPECIAL CAM GRINDER

can be estimated when we note that there are six of these 8-inch holes in a half-circumference.

An Indexing Device for Milling Piston Rings

We turn again to the milling department, and see in our half-tone, Fig. 10, a milling fixture adapted to a hand-milling machine and used for milling clearance on the sides of piston rings. These rings are clamped to the recess in the plate of the fixture by means of countersunk head screws. The operation consists in milling wide, shallow grooves in the sides of the ring, in order that the amount of surface in contact between any two rings will be very little and thus prevent their sticking together when in use. The fixture is automatic to the extent that it indexes itself when the table is moved back after the cutting traverse. This indexing is accomplished by the arm which is shown between the table and the pillar of the machine and which fulcrums on the bracket which is fastened to the dovetail of the knee.

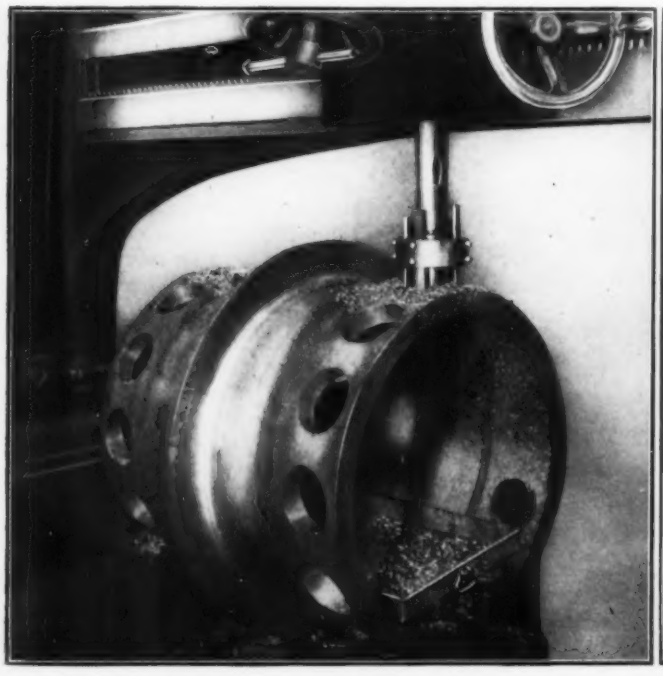


FIG. 7. AN INTERESTING HOLLOW MILL

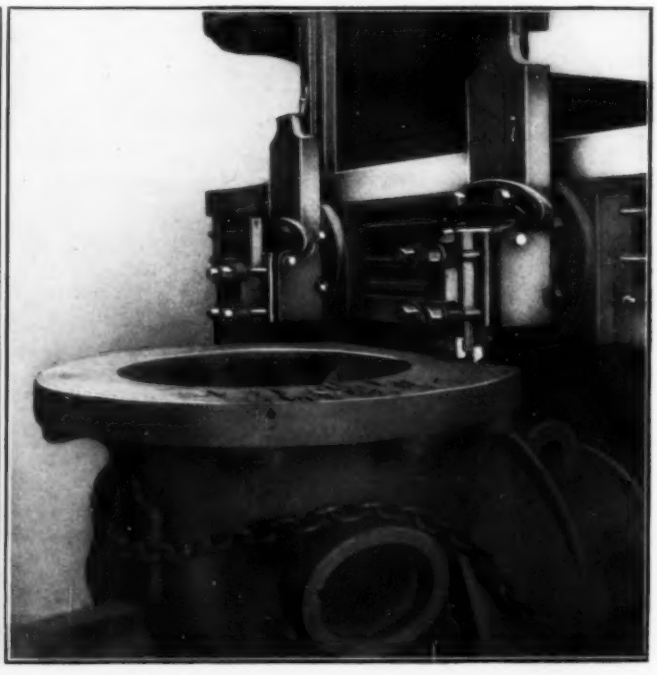


FIG. 8. A PLANER TOOL FOR FINISHING CUTS

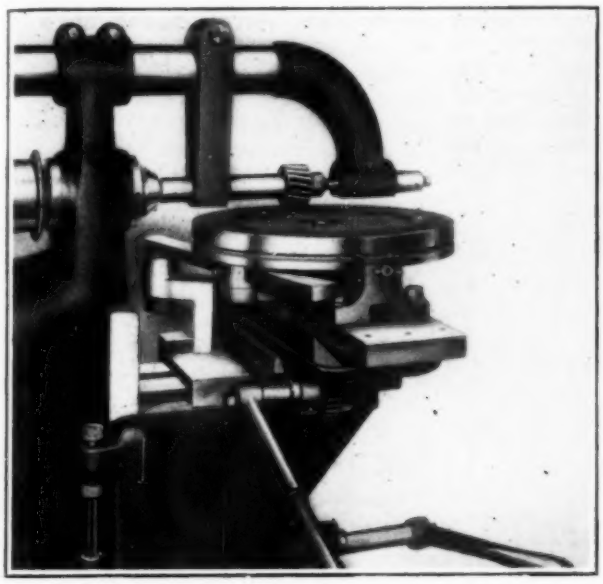


FIG. 10. A MILLING FIXTURE FOR PISTON RINGS

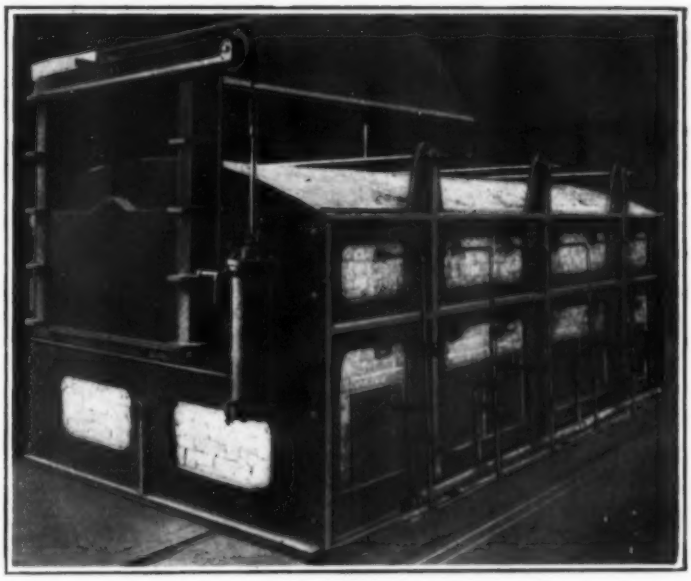


FIG. 11. AN ANNEALING FURNACE

An Annealing Furnace

As we stated in the opening of the article, the photographs with which we were furnished were of the best and showed the details of the various fixtures in operation so clearly that the detailed description seemed almost unnecessary. This statement is true of the annealing furnace as shown by Fig. 11. It is neat and substantial in design and has the unusual and useful feature of an air-operated furnace door. It is double ended, that is, with a door at each end, both of which are operated as shown. While it is used mainly for annealing, it is still as useful for case-hardening. The general character of the forging shop in which this furnace is located can be imagined by the excellence of this photograph from which our half-tone was made. We are surely safe in saying that there are but few forging shops in the country in which such a photograph could be taken. Of course the fact that the fuel used is natural gas has

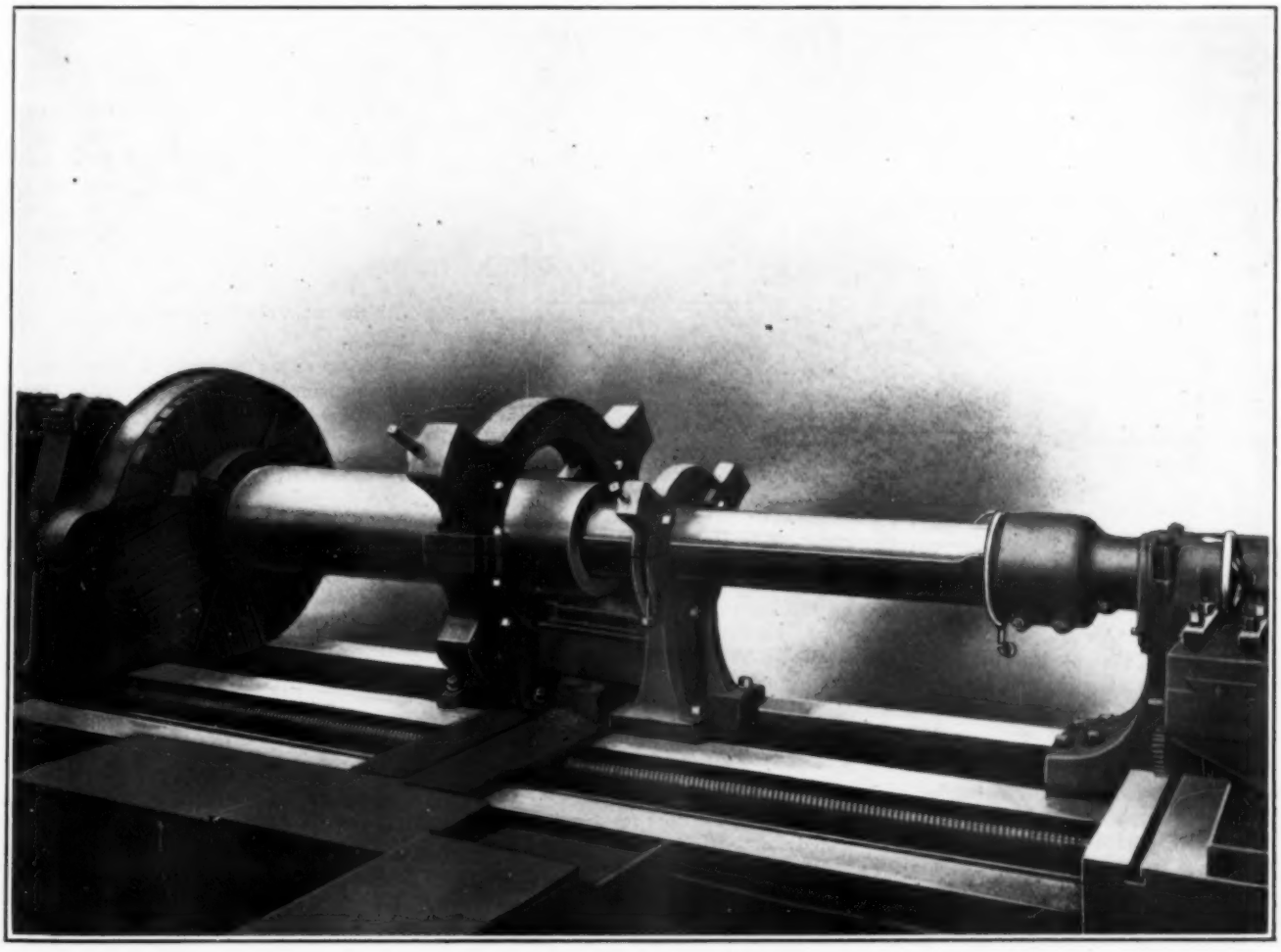


FIG. 12. A 16½-INCH HOLLOW DRILL AT WORK

something to do with the cleanliness and the absence of smoke and soot.

A Large Hollow Drill

It is usually considered characteristic of a pleasing meal to leave the best until the last. While the interest in special fixtures and tools is largely dependent upon a reader's standpoint, still we are sure that we have left one of the most interesting of the appliances seen at the plant of the Westinghouse Machine Company for consideration in the closing of this article. It is a hollow drill which drills a hole 16½ inches in diameter and leaves a core 13½ inches in diameter. Fig. 12 shows it at work upon a turbine spindle, while Fig. 13 gives details of the holder, shank and head, and the cutters are shown by Fig. 14. The drill holder is of cast iron and fits over the footstock spindle. The shank is of 15-inch extra-heavy pipe, turned to fit the holder on one end, and the cutter head on the other. It is slightly grooved at three points on top and at each end of the horizontal diameter; in these grooves are inserted brass oil pipes which are connected with a header and source of supply near the holder. The cutter head is of steel, fitted and keyed to the shank. It has six hardened-steel strips set flush with the outer ends and ground to the exact diameter of the hole which is to be drilled, in this case 16½ inches. These strips bear against the inside of the hole as it is drilled and thus furnish a support and guide as the drill advances. Two cutters or blades are used, with serrated edges, so spaced that the corners of the serrations overlap and thus break up the chips. These are well shown by the detail, Fig. 14. The speed of this large drill is 20 feet per minute, and the feed used is 1/64 inch per revolution. A copious supply of cutting compound is used, as is shown by the stream which is running from the bore. The core which is cut from the shaft feeds back inside the pipe or shank, which it clears by a small amount.

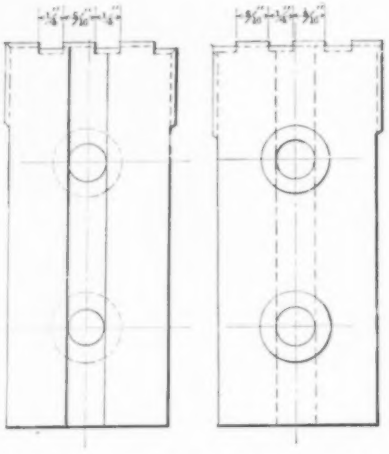


FIG. 14. CUTTERS FOR HOLLOW DRILL

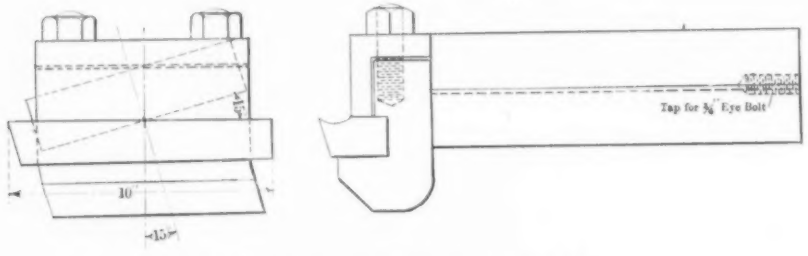


FIG. 9. DETAILS OF PLANER TOOL AND HOLDER

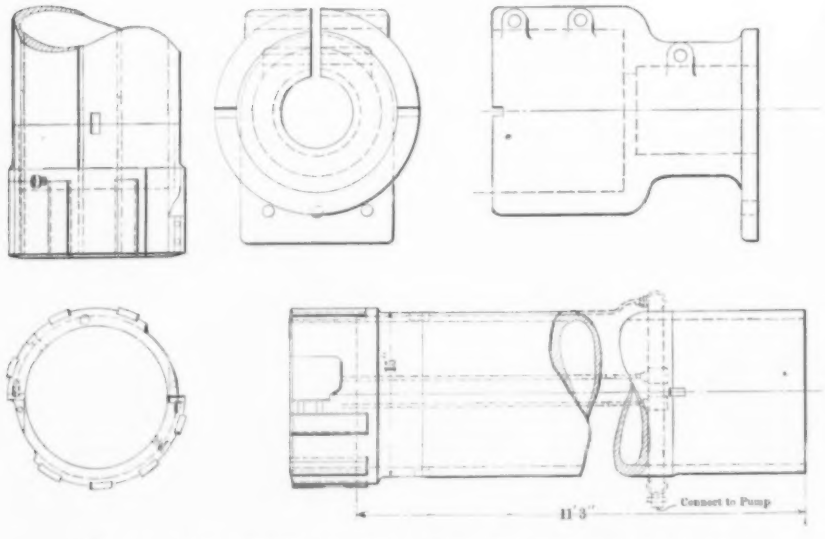


FIG. 13. HEAD, HOLDER AND SHANK FOR 16½-INCH HOLLOW DRILL

A New Arrangement of a Worm-gear Drive

By T. M. Lowthian

A recent British patent is illustrated by the line engravings Figs. 1 and 2. It refers to worm gearing where the pressure on the teeth, or the speed, tends to be excessive; the object of the device is to provide an arrangement by which worm wheels of large size need not be used, the teeth of smaller wheels need not be exposed to an excessive pressure, nor the worm compelled to run at too great a speed. Fig. 1 is an end elevation and Fig. 2 a plan view of a machine headstock with the main shaft driven by the arrangement.

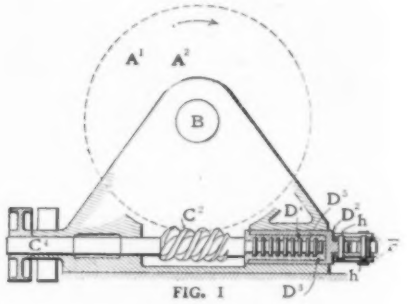


FIG. 1

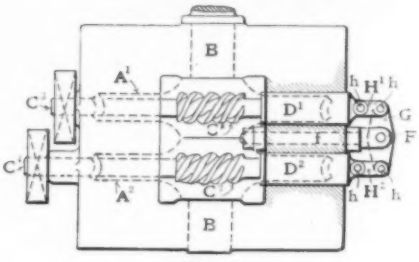


FIG. 2

A NEW ARRANGEMENT OF A WORM-GEAR DRIVE

Taking as an example a worm wheel whose diameter, to transmit a given load, would be objectionally large, the difficulty is avoided by using two worm wheels A_1 and A_2 (shown dotted in Fig. 2) of half the diameter. These are set at a suitable distance apart and side by side on the shaft B. By this arrangement either the pressures or the speeds may be reduced one-half. The two wheels are driven, respectively, by worms C_1 and C_2. The worm shafts C_3, C_4 may be driven in any convenient way; their ends are continued to suitable thrust bearing, as at D_1, D_2.

In case these bearings are collar bearings, as at D_4, half bushings, cylindrical externally, are arranged to fit into the sliding sleeves D_1 and D_2. The sleeves in their turn fit into guides which may be cylindrically formed in the bed plate or headstock B of the driving gear.

Midway between the worm shaft centers is arranged a fulcrum F, for a compensating beam G, whose length suits the distance apart of the worm shafts. Con-

necting links H_1 and H_2 are used to join the ends of the compensating beam to the ends of the sliding sleeves by pins at h, h, h, h, and this completes the appliance.

It follows that no work can be done by either worm without using the other as its abutment; hence the equality of the load on, and the work done by, each worm is at once secured.

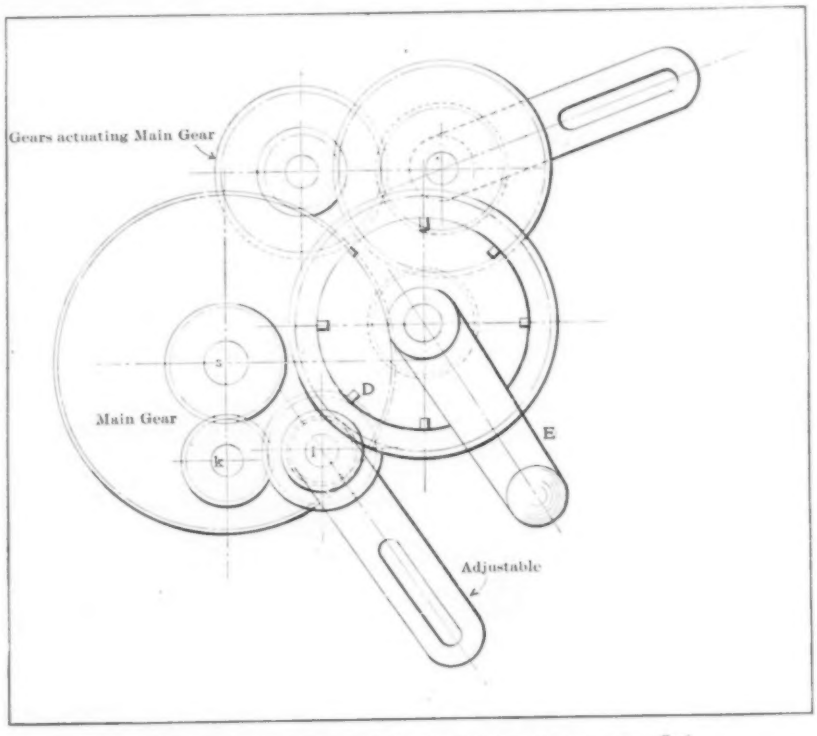
An Old Patent on a Supposedly New Invention—Differential Indexing

By John Edgar

The old adage, "There's nothing new under the sun," is gaining prestige every day and seems to be based on facts, evidence of which is continually cropping up. How often are ideas placed before the public—all in good faith—as new, which are known to many to have been old ones years ago. It is often a fact that an invention precedes the need. Many money-coining devices are in use today that have waited long for someone to take them up and push them. The term of a patent is short; it often takes more than the term of the patent to develop an idea that is basic in principle so as to get it down to a working basis. Some attorneys appreciate this fact and keep their application pending as long as possible in order to lengthen its term of protection.

Some years ago there appeared in these columns a discussion on the subject of the division of the circle into a number of equal parts when the desired spacing was prime. Many schemes were set forth, but that which finally was adopted as the simplest was the differential-indexing system, as worked out then by A. L. De Leeuw, which has since come into almost general use. This system is nothing more than the old compound method of indexing prime numbers, except that it is done automatically and is much simpler in operation.

In a recent search made to test the validity of claims which were the basis for application for letters patent on a new index head embodying this differential feature, an old patent was dug up covering the differential system and antedating the discussion mentioned above by some 40 years, it having been issued to W. H. Brown, of Worcester, Mass., in 1856. The following paragraphs, from the records of the United States Patent Office, describe his invention and state his claim of novelty.



VARIABLE DIAL FOR DIVIDING ENGINES PAT. JAN. 15, 1856

"No. 14082 Patented, Jun. 15, 1856

"Wm. H. Brown

"Variable Dial for Dividing Engines

"The nature of this improvement consists in causing both the index E and dial D to rotate at the same time, either in the same or contrary directions, with such relative velocity that at the completion of a revolution of the main shaft S one point of division in the dial shall occupy the position which one of the others had at the beginning, or shall assume its own position having made one or more revolutions in the meantime, thereby causing a difference in the number of divisions made in a circle rotating with the main shaft from what would have been made had the dial been stationary, equal to the number of such points of division in the dial that pass a fixed point during the revolution of the main shaft—less or more, according as the dial turns in a direction with or contrary to the index.

"For this purpose is made use of a toothed wheel H fixed on the main shaft; the adjustable stud l for intermediates of various diameters, which are used for transmitting motion to the dial plate in such proportion as may be desired, teeth being cut in its outer edge for this purpose; the stud k for a second intermediate, when required to give the dial a contrary motion."

The inventor says: "I do not claim the use of gearing as a means of transmitting or varying motion.

"But what I do claim as my invention, and which I desire to secure by letters patent, is causing both the index and dial to rotate at the same time, by means substantially the same and for the purpose set forth in the foregoing specifications."

The above description, with the sketch, describes very plainly the device. One might imagine that he was reading the description of a modern milling-machine index head; but when he realizes that this was worked out before the days of the universal milling machine, he begins to wonder whether the latter part of the nineteenth century is to be credited with all the improvements that are slated to its honor.

Printed copies of this invention are not to be had from the usual source; could one be obtained, it would make interesting reading. However, there are several different editions of the records, which give more or less extensive descriptions of the invention in print. The one from which the above was taken happened to be an abridged copy, so that the full benefit cannot be had that would be obtained from the fuller editions.

The simplicity of the claim made is an example in comparison with the jumbled mess that such claims are frequently presented in. No wonder that different versions of a claim are possible. Here, however, as will be noted, the inventor states his claim, which is a basic one, in good straight English with no superfluous words or phrases.

Rails weighing about 120 pounds per yard are being tried on the Belgian State Railways. It is considered that the present 80-pound rails are not sufficiently heavy and strong for main-line traffic, in view of the great increase in weight of locomotives and carriages. Some 100-pound rails are in use, but mainly at turnouts and crossings. With the new rails, heavier fish-plates are used, and the sleepers are spaced 20 inches to 24 inches center to center instead of 32 inches. The rails are all of the tee section.—*The Engineer.*

Finding Change Gears by Prime-factor Tables

How Change Gears Are Calculated by Prime-factor Tables, General Instructive Examples and a Factor Table from 1 to 10,000

BY JOHN PARKER*

Selecting suitable change gears for cutting spirals on a universal milling machine involves a calculation which is simplified by the use of a table of prime factors. The purpose of this article is to show by a few examples how simple a matter it is to figure out change gears when a table of factors is at hand. The tables here given extend to 10,000, which is as high as is necessary for the majority of problems. In order that the tables may be condensed as much as possible, the numbers divisible by 2 and 5 are omitted, as these are readily computed; only the lowest factor is given, as by dividing the number by its lowest factor we have only to refer to the table to see whether the remainder is prime or composite.

The examples are based on 10 as being the ratio between the table-feed screw and the spiral head spindle, or, in other words, the table will travel 10 inches while the spiral head spindle is making one revolution, assuming the gearing between table screw and spiral head worm to be equal. This, no doubt, is the common ratio of the different makes of universal milling machines. In many cases where the exact lead of a spiral is required, gears other than those furnished with the machine will have to be special; where many spirals of varying leads are being cut, it is very desirable to have a full set of change gears, ranging from the smallest, 24 teeth, to the largest, about 110 teeth. This insures accurate leads, a saving of time by having the gear on hand; and reduces the figuring to a minimum. The gears furnished with a Brown & Sharpe machine are two of 24 teeth, and one each of 28, 32, 40, 44, 48, 56, 64, 72, 86 and 100 teeth. These gears are mentioned, as they will be referred to in some of the examples. In cases where the exact lead is not essential and it is not expedient to make special gears, excellent results can be obtained by employing continued fractions. In the three examples given I have also shown the application of this method.

General Formulas

$$\frac{\textit{lead of spiral}}{10} = \frac{\textit{followers}}{\textit{drivers}}.$$

Actual lead obtained =

$$\frac{10 \times \textit{followers}}{\textit{drivers}}$$

*Milling-machine designer, the Brown & Sharpe Manufacturing Company.

Example 1

Given a lead of 31.328 inches, find the necessary gears. Factoring, we have:

$$\frac{31,328}{10,000} = \frac{7832}{2500} = \frac{1958}{625} = \frac{2 \times 979}{25 \times 25}.$$

Referring to the table, we find that the lowest factor of 979 is 11, and $\frac{979}{11} = 89$.

Then

$$\frac{2 \times 11 \times 89}{25 \times 25} = \frac{22 \times 89}{25 \times 25} = \frac{44 \times 89}{50 \times 25}.$$

The actual lead obtained =

$$\frac{10 \times 44 \times 89}{50 \times 25} = 31.328 \text{ inches},$$

the required lead.

In this case all gears are special except the 44-tooth, and it is probably about the best that could be done if the exact lead is insisted upon. We will try what the results will be by using continued fractions, so that the regular gears may be used entirely or as far as possible.

$$\frac{31,328}{10,000}$$

10,000) 31,328 (3
30,000
1,328) 10,000 (7
9,296
704) 1,328 (1
704
624) 704 (1
624
80

80) 624 (7
560
64) 80 (1
64
16) 64 (4
64

3	7	1	1	7	1	4
$\frac{1}{0}$	$\frac{3}{1}$	$\frac{22}{7}$	$\frac{25}{8}$	$\frac{47}{15}$	$\frac{329}{105}$	$\frac{376}{120}$	$\frac{1958}{625}$

Inverting these fractions, so as to have the followers for the numerator and the drivers for the denominator, according to the general formula, we have:

$$\frac{1}{0} \quad \frac{3}{1} \quad \frac{22}{7} \quad \frac{25}{8} \quad \frac{47}{15} \quad \frac{329}{105} \quad \frac{401}{128} \quad \frac{1958}{625}.$$

We need not consider the last fraction, as this has already been treated. Taking the next fraction and referring to the table of factors, we see that 401 is prime, 113 is prime in the next one, and 47 in the next. If we selected this fraction, we would have:

$$\frac{47}{15} = \frac{47 \times 1}{3 \times 5} = \frac{47 \times 8}{24 \times 5} = \frac{47 \times 64}{24 \times 40}.$$

All are regular gears but the 47-tooth. The actual lead obtained =

$$\frac{10 \times 47 \times 64}{24 \times 40} = 31.333 \text{ inches};$$

and as the required lead is 31.328 inches, the error is 0.005 inch. By taking the next fraction, no special gears would be required, but of course the error would be greater, thus:

$$\frac{25}{8} = \frac{25 \times 1}{8 \times 1} = \frac{100 \times 24}{32 \times 24} = \frac{100 \times 48}{64 \times 24}.$$

The actual lead obtained =

$$\frac{10 \times 100 \times 48}{64 \times 24} = 31.25 \text{ inches};$$

an error of 0.078 inch.

Example 2

Given a lead of 7.743 inches, find the necessary gears. The lowest factor of 7743 is 3, and $\frac{7743}{3} = 2581$. Again the lowest factor of 2581 is 29 and $\frac{2581}{29} = 89$. Then

$$\frac{3 \times 29 \times 89}{100 \times 100} = \frac{87 \times 89}{100 \times 100},$$

which gives followers of 86 and 89 teeth and drivers of 100 and 100 teeth. The actual lead obtained =

$$\frac{10 \times 87 \times 89}{100 \times 100} = 7.743 \text{ inches},$$

as required.

This necessitates three special gears, and it is doubtful if they could be used, because they are so large.

By continued fractions, we get:

$$\frac{7743}{10,000}$$

7.743) 10.000 (1
7.743
2.257) 7.743 (3
6.771
972) 2.257 (2
1.944
313) 972 (3
939
33

33) 313 (9
297
16) 33 (2
32
1) 16 (16
16

1	3	2	3	9	2	16
$\frac{1}{1}$	$\frac{4}{3}$	$\frac{9}{7}$	$\frac{31}{24}$	$\frac{288}{223}$	$\frac{607}{470}$	$\frac{7743}{10000}$

NOS. 1 TO 2499.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
01	.	.	.	3	7	.	.	3	.	.	.	3	17	7	3	.	.	.	3	19	.	3	.	.	3	11	31	3	7
03	.	.	.	7	3	13	.	.	3	19	11	3	17	.	.	3	.	.	23	3	7	13	3	11	.	.	3	.	.	7	3
07	.	.	.	3	.	.	11	3	.	.	7	3	.	19	3	17	.	.	3	11	.	3	13	.	.	3	7	.	.	3	29
09	3	.	.	11	3	.	.	.	.	3	.	.	.	.	3	7	.	.	3	.	.	.	.	3	23	7	.	3	47	.	.	3
11	.	.	3	.	.	.	3	7	13	3	.	.	.	3	11	7	3	17	.	.	3	29	.	.	3	.	.	.	3	.	.	.
13	.	.	.	3	.	.	7	3	.	.	23	.	3	11	.	.	3	.	.	13	3	17	.	.	3	7	.	.	3	.	.	3	19
17	.	.	3	7	.	.	3	11	.	.	3	19	7	3	.	.	.	.	3	13	37	3	17	23	3	.	.	29	3	7	.	.
19	.	.	7	3	11	.	.	3	.	.	.	3	.	.	.	3	23	.	.	3	7	.	.	3	17	19	3	13	7	3	41	
21	3	11	13	3	.	.	.	3	7	.	.	3	.	19	3	.	.	7	3	.	.	.	.	3	17	43	3	.	.	11	3	
23	.	.	3	.	.	17	3	.	.	7	3	.	.	13	3	.	.	.	.	3	.	.	.	.	3	7	11	.	3	23	.	
27	3	.	.	.	.	3	7	17	3	.	.	.	3	13	7	3	.	.	.	.	3	.	11	.	3	41	.	.	3	17	13	3
29	.	.	3	.	.	7	3	23	17	3	.	.	.	3	.	.	.	3	.	.	11	3	7	31	3	.	.	.	3	17	7	
31	.	.	.	3	.	.	.	3	.	.	17	3	7	.	.	3	.	.	11	3	.	.	7	3	.	.	3	.	.	23	3	11
33	3	7	.	.	3	.	.	13	3	.	.	7	3	.	.	11	3	31	.	.	3	23	.	.	.	.	19	3	7	.	.	3
37	.	.	.	3	.	.	19	3	7	11	3	.	.	17	3	.	.	7	3	29	.	.	3	11	13	3	.	.	.	.	3	.
39	3	.	.	.	3	.	.	7	3	.	.	.	3	.	.	3	13	.	.	3	11	37	3	7	.	.	3	.	.	.	.	3
41	.	3	.	11	3	.	.	.	3	29	.	.	3	7	17	3	11	23	3	.	.	7	3	13	.	.	3	.	.	.		
43	.	11	3	7	.	.	3	.	.	.	3	23	7	3	11	17	3	.	31	3	19	29	3	.	.	.	.	3	7			
47	.	3	13	.	.	3	.	.	3	7	.	3	31	29	3	.	7	3	.	.	.	3	23	19	3	.	.	.	.			
49	7	.	3	.	.	.	3	11	7	3	13	.	.	3	.	19	3	.	17	3	43	.	.	3	7	13	3	31				
51	3	.	.	.	3	11	19	3	.	.	23	3	.	.	3	7	.	.	3	13	17	3	.	.	7	3	.	.	.	3		
53	.	3	11	.	.	3	7	.	.	3	.	.	.	3	7	3	.	.	3	.	.	17	3	.	.	.	3	13	11			
57	3	.	.	3	.	.	.	3	.	.	.	3	7	13	3	23	31	3	.	.	7	3	19	11	3	37	.	.	3			
59	.	3	7	.	3	13	.	.	3	.	.	7	3	19	.	.	3	.	.	3	.	11	3	29	17	3	7	.				
61	.	7	3	19	.	.	3	.	.	.	3	31	.	.	3	13	.	.	3	7	11	3	.	37	3	.	.	7	3	23		
63	3	.	.	.	3	.	.	.	3	7	.	.	3	.	.	.	3	29	7	3	.	41	3	13	.	.	3	31	17	3		
67	.	.	3	.	.	.	3	23	13	3	.	11	3	7	.	3	.	.	.	.	3	.	7	3	11	.	.	3	.			
69	3	13	.	3	7	.	.	3	.	11	3	.	.	7	3	37	13	3	.	29	3	11	.	.	3	.	.	23	3			
71	.	3	.	7	3	.	11	3	13	.	.	3	.	31	3	.	.	.	3	7	.	.	3	19	13	3	.	.	7			
73	.	.	3	.	.	11	3	.	.	.	3	7	29	3	19	.	.	3	11	7	3	.	.	.	3	41	.	.	3	.		
77	7	3	.	13	3	.	.	.	3	.	.	.	3	11	.	.	3	7	19	3	.	.	.	3	31	7	3	.	.			
79	.	.	3	.	.	.	3	7	19	3	11	13	3	.	.	7	3	.	23	3	.	.	.	.	3	.	43	3	37			
81	3	.	.	3	13	7	3	11	.	3	23	.	3	.	.	.	3	41	13	3	7	.	3	.	.	.	.	3				
83	.	3	.	.	3	11	.	3	.	.	3	7	.	3	.	.	.	3	.	.	7	3	.	37	3	.	.	13				
87	3	11	7	3	.	.	3	.	.	3	.	.	3	19	.	3	7	.	.	3	.	.	3	.	.	7	3					
89	.	3	17	.	3	19	13	3	7	23	3	29	.	3	.	7	3	.	.	.	3	.	11	3	.	19						
91	7	.	3	17	.	3	.	7	3	.	.	3	.	13	3	37	19	3	31	11	3	7	29	3	47						
93	3	.	.	3	17	.	.	3	13	19	3	.	.	3	7	.	3	.	11	3	.	7	3	.	.	3						
97	.	.	7	3	17	.	.	3	.	.	3	.	11	3	.	.	3	7	.	3	13	.	.	3	11	.	3					
99	3	.	13	3	.	.	.	3	17	29	3	7	11	3	.	.	3	.	7	3	.	.	3	11	.	3					

NOS. 2501 TO 4999.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
01	41	3	37	.	3	.	7	3	.	19	3	13	.	3	47	.	3	.	11	3	7	43	3	.	13
03	.	19	3	.	.	3	29	.	3	41	31	3	7	.	3	.	11	3	13	7	3	.	.	3	.
07	23	3	.	7	3	31	13	3	.	.	3	.	11	3	.	.	3	7	59	3	.	17	3	11	7
09	13	.	3	53	.	3	.	.	3	7	11	3	.	13	3	19	7	3	31	.	3	11	17	3	.
11	3	7	.	3	41	.	3	13	7	3	.	23	3	37	.	3	.	.	3	11	13	3	7	17	3
13	7	3	.	29	3	23	11	3	.	.	3	.	47	3	7	.	3	11	19	3	.	7	3	.	17
17	3	.	11	3	.	7	3	.	31	3	.	.	3	11	.	3	23	.	3	7	.	3	53	.	3
19	11	3	.	.	3	.	.	3	.	13	3	7	.	3	.	.	3	.	7	3	.	31	3	61	.
21	.	.	3	7	23	3	.	.	3	11	7	3	61	3	3	.	13	3	29	.	3	.	.	3	7
23	3	43	7	3	37	.	3	11	.	3	13	.	3	.	.	3	7	41	3	.	.	3	.	7	3
27	7	37	3	11	.	3	53	7	3	23	.	.	3	.	43	3	.	.	3	.	19	3	7	29	3	13
29	3	11	.	3	29	13	3	.	.	3	.	19	3	7	.	3	.	.	3	43	7	3	.	11	3
31	.	3	.	19	3	7	31	3	.	47	3	.	7	3	.	29	3	.	61	3	23	11	3	.	.
33	17	.	3	.	7	3	13	53	3	.	.	3	.	.	3	37	.	3	7	11	3	41	.	3	.	.
37	43	3	7	.	3	.	.	3	47	7	3	.	37	3	31	11	3	19	.	.	3	13	.	3	7
39	.	7	3	17	.	.	3	43	41	3	19	.	3	.	11	3	7	.	3	.	23	3	.	7	3	11
41	3	19	.	.	3	17	.	3	7	13	3	.	11	3	23	7	3	41	.	3	.	19	3	11	47	3
43	.	3	13	.	.	3	17	7	3	.	11	3	.	19	3	.	13	3	.	43	3	7	.	3	29	.
47	3	.	41	3	7	11	3	17	.	.	3	.	7	3	.	.	3	11	31	3	.	.	3	47	37	3
49	.	3	.	7	3	.	47	3	17	.	.	3	41	23	3	11	.	3	7	.	3	.	.	3	13	7
51	.	11	3	.	13	3	23	.	.	3	7	53	3	11	.	.	3	.	7	3	19	.	3	.	.	3
53	3	7	.	3	.	43	3	.	.	7	3	11	13	3	.	59	3	.	.	.	3	61	29	3	7	23	3
57	.	.	.	.	3	.	7	.	3	.	.	3	13	7	3	.	.	.	3	.	.	.	3	.	67	3	.
59	3	.	31	3	11	7	3	.	.	3	.	.	3	17	37	3	.	.	3	7	47	3	.	43	3	
61	13	3	11	.	3	.	29	3	.	.	3	7	.	3	17	31	3	.	7	3	.	59	3	.	11	
63	11	.	3	7	.	3	.	13	3	.	7	3	53	.	3	17	23	3	.	.	3	.	.	11	3	7
67	17	3	.	47	3	.	.	3	7	.	3	19	.	3	.	7	3	17	11	3	.	13	3	31	.	
69	7	17	3	19	.	3	.	7	3	.	43	3	.	53	3	13	11	3	17	41	3	7	19	3	.	
71	3	.	17	3	.	37	3	.	.	3	.	.	3	7	11	3	43	.	3	17	7	3	13	.	.	3
73	31	3	47	13	3	7	19	3	.	23	3	.	7	3	29	.	.	3	.	.	3	17	.	3	11	.
77	3	.	.	3	13	17	3	29	11	3	7	.	3	.	41	3	.	7	3	11	23	3	17	.	.	3
79	.	.	3	.	.	3	.	11	3	31	7	3	13	.	3	23	.	3	11	29	3	19	.	3	7	13
81	29	7	3	43	11	3	.	17	3	59	.	3	19	.	3	7	37	3	13	.	3	31	7	3	17	
83	3	.	11	3	19	.	3	7	17	3	.	29	3	11	7	3	47	.	3	.	3	.	19	3		
87	13	.	3	.	29	3	.	19	3	11	17	3	7	13	3	61	53	3	41	7	3	43	.	3	.	
89	3	.	.	3	7	.	3	11	.	3	37	7	3	.	.	3	59	.	3	67	13	3	.	.	3	
91	.	3	.	7	3	11	.	3	.	.	3	.	17	3	13	.	3	7	3	.	.	3	67	7		
93	.	.	3	11	41	3	3	1	37	3	7	.	3	.	17	3	.	7	3	23	.	3	13	.	3	
97	7	3	.	.	3	19	23	3	43	13	3	.	.	3	7	17	3	.	.	.	3	.	7	3	59	19
99	23	.	3	13	.	.	3	7	.	3	.	59	3	29	7	3	.	13	3	53	11	3	37	.	3	.

NOS. 5001 TO 7499.

	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
01	3	.	7	3	11	.	3	.	.	3	17	.	3	.	37	3	7	.	3	67	.	3	19	7	3
03	.	3	11	.	3	.	13	3	7	.	3	17	.	3	19	7	3	.	3	.	3	47	.	3	67	11
07	3	.	41	3	.	.	3	13	.	3	.	31	3	7	43	3	.	19	3	.	7	3	.	.	3
09	.	3	.	.	3	7	71	3	37	19	3	41	7	3	13	23	3	.	11	3	43	.	3	.	31
11	.	19	3	47	7	3	31	.	3	23	.	3	.	.	3	17	11	3	7	.	3	13	.	3	.
13	3	.	13	3	.	37	3	29	.	3	7	.	3	59	11	3	17	7	3	31	.	3	.	71	3
17	29	7	3	13	3	.	41	.	3	61	11	3	.	.	3	7	13	3	17	.	3	11	7	3	.
19	3	.	17	3	.	.	3	7	11	3	13	29	3	71	7	3	.	.	3	11	.	3	.	13	3
21	.	3	23	17	3	.	7	3	.	31	3	.	.	3	.	.	3	11	19	3	7	.	3	.	41
23	.	47	3	.	11	3	.	59	3	.	19	3	7	.	3	11	37	3	.	7	3	17	31	3	13
27	11	3	.	7	3	.	17	3	.	.	3	11	13	3	.	61	3	7	.	3	.	.	3	17	7
29	47	23	3	73	61	3	13	17	3	7	.	3	.	.	3	.	7	3	.	13	3	.	.	3	17
31	3	7	.	3	.	.	.	3	11	7	3	37	.	3	13	59	3	19	53	3	29	79	3	7	.	3
33	7	3	.	.	3	11	43	3	19	17	3	.	23	3	7	47	3	.	.	3	13	7	3	.	.
37	3	11	.	3	.	7	3	.	13	3	.	17	3	.	41	3	.	.	3	7	31	3	.	11	3
39	.	3	13	19	3	29	.	3	.	.	3	7	17	3	47	13	3	23	7	3	.	11	3	41	43
41	71	53	3	7	.	.	3	.	.	3	13	7	3	79	17	3	31	29	3	.	11	3	37	13	3	7
43	3	37	7	3	.	23	3	.	.	3	.	17	3	7	11	3	53	.	3	.	3	13	7	3	.	7
47	7	.	3	.	13	3	.	7	3	19	.	3	.	11	3	.	17	3	41	.	3	7	.	3	11
49	3	19	29	3	.	31	3	.	.	3	23	11	3	7	.	3	61	17	3	.	7	3	11	.	3
51	.	3	59	.	3	7	.	3	.	11	3	.	7	3	.	.	3	43	13	3	11	.	3	.	.
53	31	.	3	53	7	3	.	11	3	.	.	3	13	.	3	.	.	3	7	17	3	23	.	3	29
57	13	3	7	11	3	.	.	3	.	7	3	47	.	3	11	79	3	29	.	3	.	17	3	7	.
59	.	7	3	23	53	3	.	13	3	59	73	3	11	.	3	7	.	3	19	.	3	.	7	3	.
61	3	13	.	3	43	67	3	7	.	3	11	61	3	.	7	3	.	.	3	.	23	3	53	17	3
63	61	3	19	31	3	.	7	3	11	67	3	.	.	3	23	.	3	.	.	3	7	13	3	37	17
67	3	.	23	3	7	19	3	73	.	3	7	3	.	29	3	59	67	3	.	37	3	13	53	3	
69	37	3	11	7	3	.	.	.	3	47	3	31	.	3	.	.	3	7	.	3	.	67	3	.	7
71	11	.	3	41	.	3	53	29	3	7	13	3	.	23	3	.	7	3	.	.	3	71	11	3	31
73	3	7	.	3	13	.	3	23	7	3	.	.	3	.	.	3	13	3	19	11	3	7	73	3	
77	.	31	3	19	.	3	7	53	3	43	59	3	.	7	3	.	11	3	13	.	3	19	3	.	
79	3	.	.	3	.	7	3	.	.	3	.	37	3	.	11	3	.	.	3	7	.	3	29	47	3
81	.	3	.	.	3	.	13	3	.	3	7	11	3	.	.	3	.	7	3	73	43	3	11	.	
83	13	71	3	7	.	3	.	.	3	31	7	3	61	13	3	29	41	3	.	.	3	11	.	3	7
87	.	3	17	.	3	37	11	3	7	.	3	23	.	3	13	7	3	11	71	3	19	.	3	83	.
89	7	.	3	17	11	3	.	7	3	53	.	3	19	.	3	11	.	3	83	29	3	7	37	3	.
91	3	29	11	3	17	.	3	.	43	3	.	41	3	7	.	3	.	3	.	7	3	23	19	3	
93	11	3	67	.	3	7	.	3	71	13	3	11	7	3	43	19	3	.	61	3	41	.	3	.	59
97	3	.	.	3	23	29	3	11	.	3	7	.	3	.	73	3	37	7	3	.	47	3	.	13	3
99	.	3	7	.	3	11	41	3	17	7	3	.	.	3	67	.	3	13	.	3	31	23	3	7	.

NOS. 7501 TO 9999.

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
01	13	11	3	29	.	3	.	59	3	31	.	3	7	13	3	.	19	3	71	7	3	.	89	3	.
03	3	.	.	3	7	53	3	13	19	3	11	7	3	.	29	3	.	.	3	.	13	3	31	.	3
07	.	.	3	37	.	3	11	29	3	7	47	3	.	.	3	.	7	3	41	23	3	13	17	3	.
09	3	7	13	3	11	.	3	.	7	3	67	.	3	23	59	3	.	.	3	97	37	3	7	17	3
11	7	3	11	73	3	.	.	3	.	13	3	79	31	3	7	.	3	61	.	3	.	7	3	.	11
13	11	23	3	13	41	3	7	43	3	47	.	3	.	7	3	.	13	3	67	.	3	.	11	3	23
17	3	.	.	3	.	.	3	.	19	3	7	23	3	37	71	3	13	7	3	31	59	3	.	47	
19	73	19	3	7	.	3	23	.	3	.	7	3	.	.	3	29	11	3	.	.	3	.	.	3	7
21	3	.	7	3	89	13	3	.	53	3	.	37	3	.	11	3	7	.	3	.	.	3	.	7	3
23	.	3	.	.	3	71	.	3	7	.	3	.	11	3	.	7	3	23	.	3	89	.	3	11	.
27	3	29	.	3	23	3	19	11	3	.	.	3	7	79	3	.	.	.	3	11	7	3	71	31	3
29	.	3	59	.	3	7	11	3	.	.	3	.	7	3	.	.	3	11	19	3	13	.	3	.	.
31	17	13	3	41	7	3	47	.	3	.	19	3	.	.	3	11	23	3	7	.	3	.	37	3	.
33	3	17	11	3	.	29	3	.	13	3	7	89	3	11	.	3	.	7	3	.	.	3	.	.	3
37	.	7	3	17	.	3	79	.	3	11	.	3	.	.	3	7	.	3	.	.	3	23	7	3	19
39	3	.	71	3	17	.	3	7	3	3	.	53	3	.	7	3	13	.	3	.	.	3	.	.	3
41	.	3	.	.	3	11	7	3	19	23	3	.	.	3	.	.	3	.	.	3	7	31	3	13	.
43	19	.	3	11	13	3	17	.	3	.	.	3	7	37	3	.	41	3	.	7	3	.	.	3	61
47	.	3	61	7	3	13	.	3	17	.	3	.	.	.	3	23	83	3	7	13	3	.	11	3	43	7
49	.	.	3	47	.	3	29	73	3	7	83	3	13	.	3	.	.	7	3	.	11	3	.	.	3	.
51	3	7	23	3	.	83	3	37	7	3	17	41	3	53	.	3	.	11	3	13	.	3	7	.	3
53	7	3	.	.	3	.	31	3	.	79	3	17	.	3	7	11	3	19	47	3	41	7	3	59	37
57	3	13	.	3	73	7	3	23	61	3	43	11	3	17	13	3	.	.	3	7	19	3	11	.	3
59	.	3	.	29	3	.	41	3	13	11	3	7	19	3	17	.	.	3	47	7	3	11	13	3	.
61	.	47	3	7	19	3	.	11	3	.	7	3	.	.	3	13	.	3	11	.	3	.	43	3	7
63	3	79	7	3	.	11	3	.	.	3	.	.	3	.	.	3	7	59	3	.	73	3	13	7	3
67	7	11	3	.	31	3	.	7	3	.	13	3	11	.	3	.	89	3	17	.	3	7	.	3	.
69	3	.	17	3	13	.	3	.	.	3	11	.	3	7	.	3	53	13	3	17	7	3	.	71	3
71	67	3	19	17	3	7	.	3	11	43	3	13	7	3	.	47	3	73	.	3	17	19	3	.	13
73	.	.	3	.	7	3	11	.	3	37	.	3	31	19	3	43	.	3	7	.	3	17	29	3	.
77	.	3	7	.	3	41	13	3	.	7	3	.	67	3	47	29	3	.	.	3	61	.	3	7	11
79	11	7	3	.	79	3	.	17	3	61	23	3	.	13	3	7	67	3	83	.	3	.	7	3	17
81	3	.	31	3	23	.	3	7	17	3	.	.	3	83	7	3	.	.	3	19	11	3	.	41	3
83	.	3	43	.	3	59	7	3	83	17	3	19	.	3	13	31	3	.	11	3	7	23	3	.	67
87	3	.	13	3	7	.	3	.	.	3	31	7	3	.	11	3	.	37	3	53	.	3	.	.	3
89	.	3	.	7	3	.	19	3	.	13	3	.	11	3	89	61	3	7	41	3	43	.	3	11	7
91	.	.	3	13	61	3	.	.	3	7	11	3	59	17	3	.	7	3	.	.	3	11	.	3	97
93	3	7	.	3	.	.	3	.	7	3	13	.	3	.	17	3	29	.	3	11	53	3	7	13	3
97	71	43	3	53	11	3	7	.	3	29	.	3	19	7	3	11	17	3	.	.	3	.	97	3	13
99	3	.	11	3	19	7	3	43	37	3	.	.	3	11	.	3	.	17	3	7	29	3	41	19	3

PRIME FACTORS OF NUMBERS FROM 1 TO 9999.

The table of factors shows that 607, 223 and 31 are prime. Selecting $\frac{24}{31}$, which would require one special gear, we have:

$$\frac{24}{31} = \frac{48 \times 1}{31 \times 2} = \frac{48 \times 32}{31 \times 64}.$$

The actual lead obtained =

$$\frac{10 \times 48 \times 32}{31 \times 64} = 7.742 \text{ inches},$$

an error of 0.001 inch.

EXAMPLE 3

Given a lead of 3.769 inches, find the necessary gears. Our fraction is $\frac{3769}{10000}$. Referring to the table, we find that we cannot reduce it, as 3769 is prime. We will again try by continued fractions to find a fraction that will use the regular gears.

```
3,769 ) 10,000 ( 2
        7,538
        ------
        2,462 ) 3,769 ( 1
                2,462
                -----
                1,307 ) 2,462 ( 1
                        1,307
                        -----
                        1,155 ) 1,307 ( 1
                                1,155
                                -----
                                  152 ) 1,155 ( 7
                                        1,064
                                        -----
                                           91 )

91 ) 152 ( 1
     91
     --
     61 ) 91 ( 1
          61
          --
          30 ) 61 ( 2
               60
               --
               1 ) 30 ( 30
                    30
                    --

  2   1   1   1   7   1   1   2    30
-----------------------------------------
 1/2 1/3 3/8 4/11 31/84 35/91 66/175 167/442 3769/10000
```

The fraction $\frac{3}{8}$ appears as if regular gears could be used. Then

$$\frac{3}{8} = \frac{3 \times 1}{4 \times 2} = \frac{48 \times 28}{64 \times 56}.$$

The actual lead obtained =

$$\frac{10 \times 48 \times 28}{64 \times 56} = 3.750 \text{ inches};$$

an error of 0.019 inch. If we need a closer approximation, a special gear will be required.

Take the fraction

$$\frac{49}{130} = \frac{7 \times 7}{10 \times 13} = \frac{28 \times 56}{40 \times 104}.$$

Then the actual lead obtained =

$$\frac{10 \times 28 \times 56}{40 \times 104} = 3.7692 \text{ inches};$$

an error of 0.0002 inch.

If the finding of the number in the tables is not clear, I would explain that the top horizontal line of figures represents the hundreds and thousands, and the figures in the first vertical column the tens and digits. For example: find whether 979 is prime or not. In the first table, we find 9 in the top horizontal line, and 79 in the first vertical column. In the intersecting space is 11, which is the lowest factor.

Premium Systems—Limit Cutting in England

BY P. E. JAMES

The articles which have appeared from time to time on the premium system and limit or price cutting have proved very interesting, and if, as a result, employers are brought to see the utter futility of this dishonorable practice, you will have performed an inestimable service, not only to the victims of this obviously short-sighted policy, but to the employers themselves. In England, the trade unionist is always charged with "restricting the output"; but I am sure that where price cutting is practised, the price cutters have more to do with restricting the output than any trade union ever will have. Price cutting unites all the men, society or non-society, in a kind of freemasonry; as a job comes round, the price and time taken is handed to the man, who proceeds to do as the others have done, and the rate of output is at a standstill. Under such circumstances, the men are not to be blamed if that rate of output is a comfortable one.

If the job be a new one and therefore unpriced, one may be sure that the man will not put his head farther into the noose than necessary, so that, when the job is priced (and this pricing or estimating is often a farce, the time allowed frequently being the time taken, the *estimate* consisting merely of a *guess* as to whether the man worked hard or took it easy), his time being considered, there will, if possible, be a margin for him the next time that job comes round. To show that the men are not always to be condemned for acting thus, I will give a few instances.

There is, I believe, in England an agreement between the trade unions and the employers' federation to the effect that where the premium system is introduced, limits once set shall not be cut; but this is how some of the firms comprising this federation keep their compact. A job is done at a limit of, say, four hours. The workman does this in two hours. The report is sent in to the office and soon the drawing is recalled, a slight alteration is made, perhaps a 1/32 inch longer or shorter, a different part number is given, and the job comes out again as a new one without a limit. A new limit is then *estimated*, which oftentimes is found to be the same as the actual time taken before the job was altered. Another method is to alter the basis of calculation. For instance, in a shop where I have worked for several years, a length of shafting which two years ago received a limit of four hours today, with the same lathe, the same tools and the same methods, receives but two hours. *As the output has increased, the basis of calculation has decreased;* yet in prominent places in this shop there are notices posted intimating that "Limits once set will not be cut." What is the direct result of this policy?

Again an actual illustration. A fellow working near me has a job, the limit of which is six hours. This job used to take five hours, but by using his brains and devising better methods, he is able to do it in two hours; but he will not do it in less than three hours and a few minutes, because they will not only cut his limit, but the time in which he would do the job would form the basis of calculation for all similar jobs. In fact, he realizes that if he uses his brains beyond a certain extent he will be punished, and that that punishment will be great in proportion to the benefit his employer has reaped. Now it is very plain that such a policy is bad in every respect; bad for the employer, because the output, not being so great as it should be, the cost per piece is increased, and he finds it difficult to compete in price with other firms. This means loss of orders or smaller profits. It is bad for the man, because his wages are, of course, restricted, and the probable loss of orders means less work for him.

The great reason for all this sharp practice seems to be the result of a lack of mutual trust between master and man. If the workmen generally were brought to believe that the employer's interest is really their own, and if employers would only realize that the brains in the shop may be equal and sometimes superior to those on the staff, we should have on the workman's side better work with greater output, because he would then have no fear of being taken advantage of. While from the employers we should have none of these subterfuges which they now try to foist on the men, because they would realize what they so signally fail to do now, that as soon as their hollow proposals were made they would be seen through and bound to fail.

Recent acts of Parliament authorize the construction of some 200 additional miles of railway in the United Kingdom of Great Britain and Ireland, involving an outlay exceeding $50,000,000. The authorized constructions include railway extensions in the Midlands and other parts of the kingdom. The chief item is a projected railway in Ireland over 100 miles long, terminating on the west coast, and forming a link in a future route between England and Canada by rail across Ireland and by a direct steamship line from Blacksod Bay.

The Proper Care of Belts in the Shop

Suggestions as to Keeping Them in Good Condition and Appliances to Insure Equal Tension for All Belts Used

BY WILLIAM H. TAYLOR

A manufacturing establishment may have the most approved and up-to-date high-speed machinery and appliances and yet fail to accomplish the same results which are achieved in a shop having an inferior equipment, but a higher grade of men, whose efforts are so well directed through an efficient system of management that every move counts and all lost motion, waste of time and energy are eliminated; and the equipment, though of the older and weaker type, may be so systematically kept in first-class condition that it can always be depended upon to turn out a definite large amount of work in a definite time.

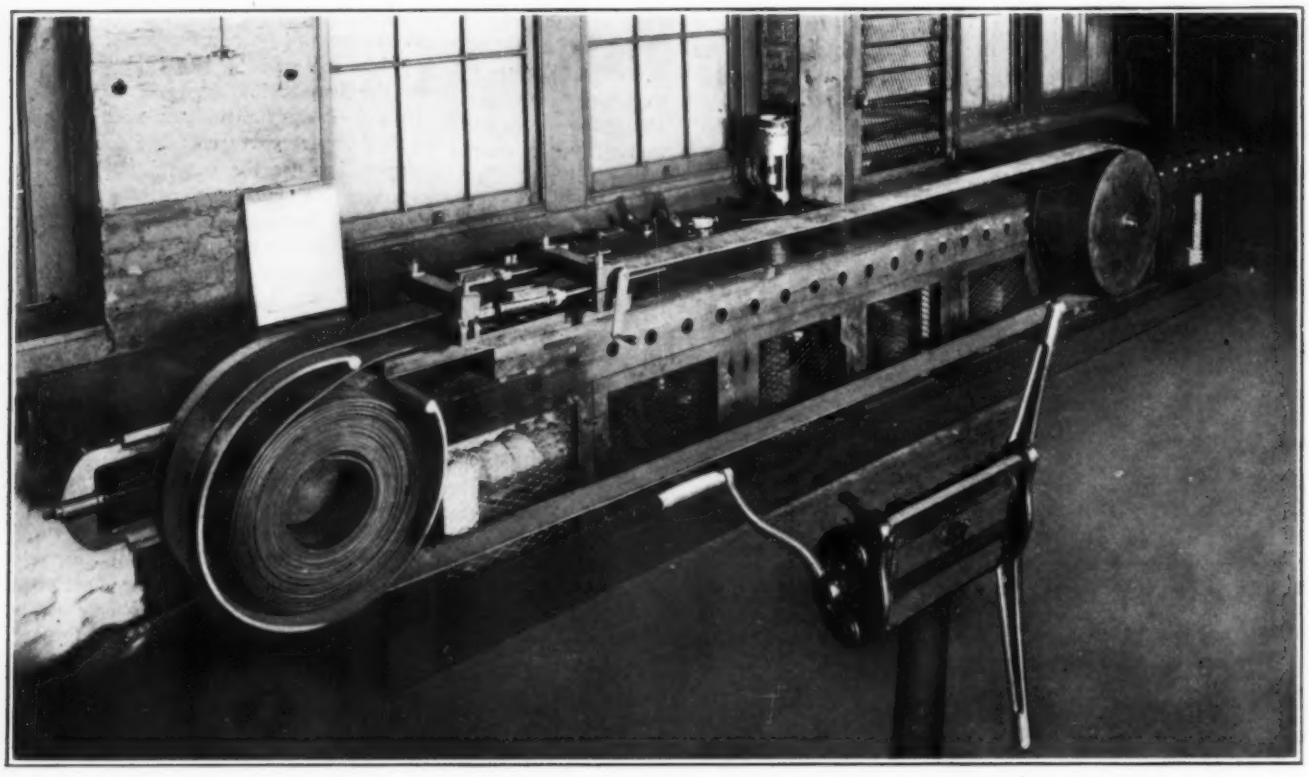


PHOTO A. D. BELT FIXER'S BENCH

This demand for a better type of works management has resulted in widespread efforts on the part of managers and superintendents to systematize their plants; in the majority of cases the results of such attempts have proved so disappointing and at times disastrous as to leave in their wake a false conclusion, that the good old "hit and miss," "go as you please" methods, where the "rule of thumb" prevails, are after all the only practical lines on which a shop can be run.

These failures result from one or more of the following causes:

The inexperience or lack of time of the parties undertaking to install the system, as is usually the case where it is undertaken by men having routine duties to perform in connection with running the plant.

The opposition which is always encountered when installing anything new.

Going ahead too fast or trying to overcome in a few months the evils of bad management and faulty shop practice which have existed for years.

The mistaken idea that good management and low cost depend upon keeping down the number of so called non-producers.

The failure to provide facilities which will enable the workman to produce more.

The failure to establish, apply and rigidly maintain standards for kinds and shapes of tools, belting, feeds, speeds, depths of cuts and methods of doing work, etc., that will insure at all times the possibility of producing uniformly large results.

Too often the *form* is mistaken for the *substance*, and instead of the "system" installed being a help and a cost reducer, it becomes a voluminous maze of red tape, defeating the object it was intended to accomplish.

In many cases the start is made at the wrong end by installing an elaborate and expensive cost system which accomplishes nothing but to show what might have been taken for granted, that the product costs too much, or by installing a premium piece-work system with no basis of setting rates other than guess-work or from records that are utterly and absolutely worthless on account of their inaccuracy. Even if such records were accurate, the conditions under which the work is to be done would make them useless, including, as they do, time spent in grinding tools, repairing belts and in doing numerous other things that the machinist should not have to do; they should be done for him by the so called non-producers and thus enable the machinist to do productive work practically all of the time.

Almost every superintendent or foreman, in attempting to bring up the speeds of the machines in his shop to something

near what he knows to be possible has found that such an attempt usually results in the belts slipping, breaking or the lacing giving out; he also knows that in a very few instances, where the care of the belts is left to the man on the machine the belts cannot be depended upon to do the maximum amount of work.

It is a fact that, in the average shop, very few belts become unfit for use through legitimate wear; they are usually ruined through accidents or improper use.

In the average shop, where the care of the belt is left to the machinist, the belts are usually far too loose; when the belt slips, the man on the machine will reduce his speed, feed and depth of cut to a point where the belt will pull, this being less trouble for him than tightening the belt, or he will use rosin on it. The use of rosin is a simple act of vandalism, as it will ruin any belt in a very short time.

running on the right cones, it would run and twist itself like a snake and was practically ruined.

I have also seen a belt, thus tightened by guess, first cut too short, then a piece inserted, then taken off and the length of the piece reduced before the proper tension was reached, a great deal of time being lost through the machine standing idle while the cutting and trying performance was going on; and it certainly did not add to the life of the belt.

Another cause for belts being ruined when laced by the man on the machine is that they are improperly laced; the ends are not cut square and the lacing on one side stretches more than on the other, thereby causing the belt to run crooked.

What the Belt, Bench and Tension Scales Accomplish

That element of the Taylor system which cares for the installation and maintenance of belts accomplishes four things of vital importance to economical production, namely:

Eliminates interruption to production from repairing belts during working hours, by having all belts systematically inspected and all break-downs and slippage anticipated before they occur.

Insures the possibility of using the maximum feeds, speeds and depths of cuts at all times.

Increases the life of a belt to an average of from six to eight years, owing to all belts being of the proper dimensions, properly laced or spliced and run at the proper tension.

Cost of maintaining the belts reduced to a minimum.

To care for the belts in a systematic manner, the man in charge of the belt repairs should have two or more belts each day to tighten or clean. It is also necessary that all repairing, tightening and inspection of belts should be done outside of the working hours, so that there will be no loss of output from interruption to manufacture. In order to accomplish these objects it is necessary to go over each belt in the shop and record on a "belting form" provided for that purpose all standard data relating to each particular belt in use. These belting forms, when bound together, afford a perpetual inventory of all belts used in the place, giving their original cost, dimensions and exact lengths to maintain the tension under which they are to run, cost of repairs, etc., and acts as an automatic inspector. The belting form is illustrated on the next page.

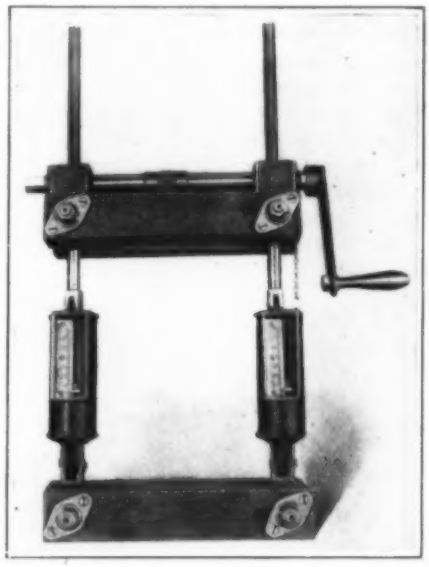


PHOTO A. C. BELT-TIGHTENING CLAMPS

The dimensions of the belts, the maximum and minimum tensions prescribed, are in accordance with Mr. Taylor's rules on belting, as described in a paper read before the American Society of Mechanical Engineers in December, 1893, and which have been incorporated in a special slide rule by Carl G. Barth. This slide rule is used in posting the required information on the belting forms.

Ticklers

After the belting forms have been properly posted, it is then necessary to lay out the dates for overhauling the belts throughout the year. The best means of regularly laying out the work for the belt fixer is a "tickler" containing a portfolio for each day in the year. A memorandum made on a loose printed slip, as shown

DM.10

OUT
IN

ORDER NUMBER
D L

DEPARTMENT

DAY RATE..... MAN'S TIME.....

MAXIMUM TENSION	MINIMUM TENSION	BELT SYMBOL	

CLEANED AND GREASED..... GREASE USED.....

DRESSED WHILE IN USE..... DRESSING USED.....

AMOUNT TAKEN OUT..... LENGTH PUT IN.....

LENGTH OF SPLICE..... CEMENT USED.....

TENSION IN LBS. INDICATED BY EACH SPRING BALANCE { BEFORE TIGHTENING..... AFTER .....

WORKMAN'S NAME..... MAN'S NO.....

ENTERED IN		
PAY SHEET	COST SHEET	BELT RECORD

..... DAY WORK TIME NOTE

TICKLER FOR CALLING ATTENTION TO BELTS NEEDING ATTENTION

is then made out for each time the belt is to be overhauled, and placed in the portfolio of that date.

Every day in the year the portfolio is opened, and all the memoranda of belts requiring fixing that day are sent to the belt fixer. After making the repairs called for, the belt fixer writes on the memo the nature of the work done by him, the time it took to do it, and any remarks as to future probable repairs; then he returns it to the clerk who attends the tickler, where the time and material are posted on the belting forms and the memorandum is again inserted in the portfolio under the date next called for.

The length of time a belt will run before the tension will fall to the minimum and overhauled before trouble is likely to occur with them; many stoppages and break-downs are thus averted. No man or even a combination of men can carry in their heads in this way the apparatus which should be inspected and repaired each day, in order to carry on repairs cheaply.

The Tension Scales and Belt-fixer's Bench

These belt-tension scales consist of two clamps connected by screws that act through spring scales, as shown in photo A C, so that when they are "wound up" the clamps are drawn together and the tension in the belt is transferred to the scales. Both the original tightening of belting, and at the same time acts as the equivalent of a pulley around which to lay the belt.

The under part of the bench is divided into compartments for carrying a stock of belting.

With this apparatus it is possible for one man to remove, tighten and replace almost any belt in from six to eighteen minutes.

When a new belt is to be fitted over a pair of pulleys, or an old belt is to be repaired or respliced, the required length is taken from the "belting form" and an order is issued, giving the necessary details, and sent to the belt fixer. The length of the belt having been previously measured over its own pulleys by means

BELTING. DEPARTMENT. ..... BELT SYMBOL.

LOCATION ..... LENGTH OVER PULLEYS ..... MAX. VELOCITY .....
PURPOSE ..... WIDTH ..... MIN. VELOCITY .....
KIND ..... THICKNESS ..... MAX. TENSION ..... } ON EACH SPRING BALANCE
MAKER'S NAME ..... CROSS SECTION IN SQ. IN. ..... MIN. TENSION ..... }
DATE PUT IN USE ..... HOW FASTENED .....
DATE TAKEN OUT ..... BELT GREASE TO BE USED ..... COST OF BELT .....
LIFE OF BELT ..... BELT DRESSING TO BE USED ..... COST OF MAINTENANCE .....
TOTAL COST .....

DATE RE-TIGHTENED	TENSION IN LBS. INDICATED BY EACH SPRING BALANCE		AMOUNT TAKEN OUT	DATE TENSION AGAIN SHOULD BE TAKEN	DATE CLEANED AND GREASED	DATE TO BE CLEANED AND GREASED AGAIN	DATE DRESSING PUT ON DURING SERVICE	GENERAL REMARKS ABOUT WORK DONE ON BELT, CONDITION OF BELT ETC.	WORKMAN'S NAME	MAN'S TIME REQUIRED TO DO WORK	COST OF WORK
	BEFORE TIGHTENING	AFTER TIGHTENING									

FORM FOR ALL DATA REGARDING THE BELTING OF A SHOP

at which it will pull all that is required has been determined by experiments; there are remarkably few cases where a belt requires attention before the time set for retightening; when this does occur, however, a belt dressing which does not injure the belt, but which will enable it to pull until noon or until the end of the day, is applied, at which time the belt fixer tightens the belt. The memorandum is removed from the tickler and another is placed in the portfolio under its next date for retightening.

The tickler will be found exceedingly useful for making all of the repairs in and about an establishment. By means of it all the machinery, buildings, and even boilers and drains, etc., may be inspected

the belt and the subsequent retightening, from time to time, are best done on a special "belt-fixer's bench," now to be described.

The special features of this bench, which is illustrated in photo A D, are:

A series of holes six inches apart along its front top rail, into any of which an arbor carrying a wooden pulley may be inserted.

A drum-like casting which by means of a screw may be adjusted to the fractional parts of a foot, along a cast-iron guide secured at the left end of the bench, the amount of adjustment being about equal to the distance between the above mentioned holes.

The drum forms a receptacle for a roll

of a steel tape, the tension is read from a slide rule provided for that purpose as before described. The arbor, with its pulley, is moved up to the hole in the top rail of the bench which will most nearly correspond to the required length when the tape line is passed around the pulley and the drum. There is a pin projecting from the top surface of the drum to which the ring on the end of the tape is hooked; then the tape is passed down around the drum, up around the wooden pulley and brought back to the pin; then with the crank handle the drum is adjusted in or out until the exact length is reproduced.

A roll of belting with the proper width and thickness is placed in the open drum;

the belt tension scales are next placed in a convenient position about a foot to the right of the gap between the top of the bench and the drum, with the clamps loosened up; then the loose end of the belt is passed up through the gap, under the clamps to the left and between the clamps to the right, over and down around the wooden pulley, back and up around the drum and between the clamps to the left, carrying the end of the belt about halfway between the two clamps. After exercising care to square up the end of the belt and center it by means of the graduations on the clamps, the left-hand clamps are tightened; then after centering the belt between the right-hand clamps, they are drawn up tight. Particular care must be exercised to distribute the clamping pressure over the whole width of the belt by drawing the clamping bolts up alternately. The scales are now ready to be "wound up." The screws are drawn up until the spring balances between the two pairs of clamps record the tension required. During the process of "winding up" care must be exercised to equalize the tension in the two strands of the belt by agitating it; this is accomplished by slapping the strands midway between the pulley and the drum. The belt is now cut off ¼ inch shorter than the amount estimated for the joint, this allowance being for the stretch on that portion of the belt which is between the clamps. The belt is now removed, laced on a belt-lacing machine and placed in position on its pulleys.

Machine lacing, using the spiral wire lacing, affords greater convenience and consumes less time in "putting on" and in "taking off" belts for the purpose of testing and tightening on the belt bench than with any other method of splicing. Only one wire joint should be employed to join the ends of any belt; cement splices should be made if a section of a belt becomes damaged and requires a new piece to be set in.

To avoid any chance of injury to a workman in shifting these belts, it is essential that the ends of the wires be bent and forced back into the leather, and it is recommended that every time a belt is tightened an inspector be sent to examine the belt and report that this has been done.

It is convenient to remember, says *Power*, that if the charge taken in by a gas engine be compressed to one-sixth its original volume—that is, if the compression ratio be 6—the compression pressure will be ten times the pressure of the charge before compression. Thus, if the suction pressure be 13½ pounds absolute, and the compression ratio be 6, the compression pressure will be about 135 pounds absolute. This compression pressure is very often used in engines for operation on producer gas.

Judgment

Judgment, good or bad, is the determining factor in all real success or failure. It is born of experience, by which one man profits more than another simply because he sees deeper into its meaning, and has the courage of his convictions. He perceives the relation of this experience to others; its influence for good or ill. He is an observer and an analyst though he know it not. The power of observation differs so greatly in individuals that it seems to be almost inborn. Nevertheless it may be cultivated, established as a habit, and made the basis for better judgment.

A well known professor of psychology has recently reported some interesting experiments tried upon his class to determine the accuracy of judgment or estimate based on observation. He asked the students, for instance, to give the number of seconds elapsing between two loud clicks. These were separated by ten seconds, but guesses and answers ranged from three-quarters up to sixty seconds. A good number judged forty-five seconds as the right time.

Again he presented a clock face over which a pointer made one revolution in five seconds, or at the rate of ten centimeters per second. For a whole minute the pointer was revolved at this rate, and students were asked to express in figures or comparative terms, the speed with which the arrow moved along. The great diversity in replies led the professor to ask, "Would it seem possible that university students, trained in observation, could watch the movement constantly through a whole minute, and yet disagree as to whether it moved as slowly as a snail, or as rapidly as an express train?" Those who judged in figures showed no less variation, ranging from one revolution in two seconds to one in forty-five seconds, from seven miles to over forty miles an hour, etc. In reality the arrow moved in one hour about one-third of a mile. Not a few of the judgments therefore multiplied the speed by more than one hundred.

Beyond all else, it is just the difference in judgment that gives us such great variety in skill among our workmen. Some may struggle far harder than others to acquire it, but the man who observes the effect of each act or motion, and what is more important still, profits by it, eventually learns to make every motion effective. The unobserving man repeats indefinitely a motion once acquired, to a certain degree regardless of consequences. The successful blacksmith is the one who has learned by trial to measure his blows to the shape he wants to give to the hot iron; a measure of the molder's success lies in his ability to judge just how hard to ram a given mold; while the machinist who is able to adjust speed and depth of cut to attain the highest efficiency is sure to lead his fellows.

The recent investigations of Taylor and his followers have shown that tremendous loss of time occurs in many industries where judgment in its best sense has not been exercised, where there has been no detailed observation, but habits have passed from generation to generation.

But physical skill is only one of the derivatives of applied judgment. On a still higher plane stands judgment of human nature, of causes and effects which cannot be reduced to mathematical terms. A species of self conceit and stubbornness is to blame for much poor judgment, an unwillingness to adopt the right course, even when it is evident, or a lack of courage to follow it. It is the broad man who sees both sides of the question; who instinctively thinks what the other man is likely to think. And it is the courageous man who, regardless of the influence of others, regulates his own action to secure the best results. In the experience of General Grant, when as a colonel in full command of troops, he prepared for his first engagement, we find a forcible confirmation of these statements. The story is worth repeating in his own words.

"As we approached the brow of the hill from which it was expected we could see Harris' camp, and possibly find his men ready formed to meet us, my heart kept getting higher and higher, until it felt to me as though it was in my throat. I would have given anything then to have been back in Illinois, but I had not the moral courage to halt, and consider what to do. When we reached a point from which the valley below was in full view, I halted. The place where Harris had been encamped a few days before was still there; the marks of a recent encampment were plainly visible, but the troops were gone. My heart resumed its place. It occurred to me at once that Harris had been as much afraid of me as I had been of him. This was a view of the question I had never taken before, but it was one I never forgot afterward. From that event to the close of the war I never experienced trepidation on confronting an enemy, though I always felt more or less anxiety. I never forgot that he had as much reason to fear my forces as I had his. The lesson was a valuable one."

The story carries its own convincing lesson.

The cement production in the United States, according to the annual report issued by the U. S. Geological Survey, continues to show greatly increased figures. In 1887 the total portland cement output in this country was 250,000 barrels of natural cement, while for the past year of 1906 the production rose to 46,000,000 barrels of portland with only 4,000,000 of natural.

Laying Out Automatic Screw-machine Cams*

How the Cams on the Brown & Sharpe Automatic Are Conveniently Laid Out for Operating the Turret and Cross Slides

BY F. E. ANTHONY†

This article is intended to give a practical idea of the method employed in laying out the cams for the Brown & Sharpe automatic screw machine. The example taken is a simple screw, but the laying out of the cams and the method employed are practically the same for a more complicated piece, excepting that the lobes of the cams would necessarily have to be designed to suit the various operations on a more complicated piece.

The system of cams employed on this type of machine was adopted by the Brown & Sharpe Manufacturing Company a number of years ago and provides for a set of cams for each piece to be made, so that when a given piece is to be undertaken it is simply necessary to place a set of cams for this piece in position; the machine is then ready to operate, except for the necessary adjustments of the turret tools and cross-slide tools.

Features of Construction

The design of the machine as a whole and the facilities for convenient adjustment of various operating parts are indicated by the accompanying half-tones, **Figs. 1 and 2.**

The turret is arranged for six tools; there are front and rear cross slides, which are operated by edge cams made from blanks 4½ inches diameter with 1-inch center hole and ¼-inch locating-pin hole. These locating-pin holes are also placed for positioning the cams and insure their being located in the proper position to give correct timing.

The turret-slide cam is carried on shaft *A*, the end shown being the shank of the clamp nut. This cam is placed on the shaft through an opening in the rear end of the machine, which gives ready access to this adjustment. The cross-slide cams are carried on the front shaft at *B* and *C*. The dogs for controlling the mechanism for reversing the spindle, opening and closing the chuck, feeding the stock and rotating the turret, can be adjusted on carriers *D*, *E* and *F*; this feature gives ease of adjustment for all operations within the capacity of the machine. The turret-rotating mechanism draws the turret slide to the rear position when indexing the turret, irrespective of the hight of the cam position. This does away with the necessity of cutting the cams back to allow the tools clearance when rotating. The reversing shaft, with carrier *D*, can be uncoupled from the front shaft for the purpose of placing the cross-slide cams on carriers *B* and *C*. The stock feed can be adjusted by crank *G*, and the change gears for obtaining different cam-shaft speeds are mounted on shafts *H* and *I*, the gear marked *H* being the driver and that marked *I* the driven.

Order of Operations

Assuming that a screw as shown in Fig. 3 is to be made from common yellow brass and the requirements are such that it is necessary to take roughing and finishing cuts to produce the desired blank size before threading, the following order of operations would be selected: rough turn with hollow mill; index turret; finish turn with box tool; index turret; thread; cut off screw; feed stock to stop; index turret.

The facing of the under side and the removing of the bur on the outer diameter of the head, as well as the indexing of the turret three times to bring the stop into position for feeding the stock for the next blank, are not considered in the above operations, as usually these operations can be performed during the time required for parting the screw from the bar.

The spindle speed, length of cuts, feed per revolution of spindle for the various cuts, the time consumed by the idle movements, such as feeding the stock, indexing the turret and reversing the spindle, also the clearance between the turret and cross-slide tools, are taken into consideration to determine the total number of revolutions of spindle required for completing the screw. The fastest spindle speed for the machine, which is 2400, can be used for brass.

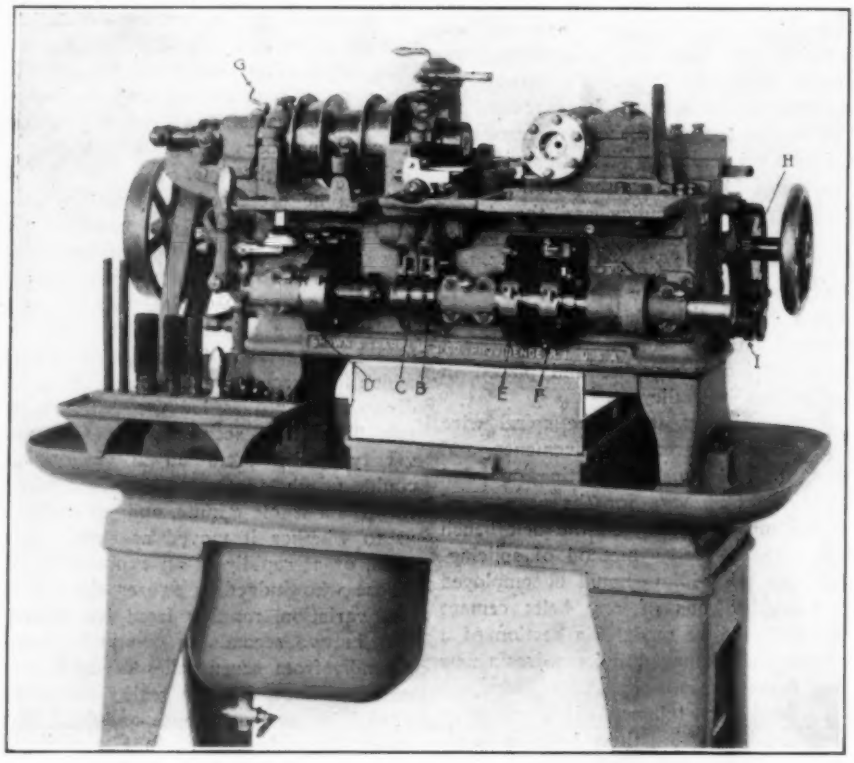


FIG. 1. FRONT VIEW, BROWN & SHARPE NO. 00 AUTOMATIC SCREW MACHINE

Determining the Number of Spindle Revolutions

To determine the number of revolutions of the spindle required for the various cuts, divide the length of cut by the feed or advance of the tool per revolution of the spindle. Calculating on a feed of 0.012 inch for roughing, which cut is 1 inch long, 83 revolutions and a fraction of a revolution will be required. As it is not practicable to consider fractions of revolutions, the roughing cut will be given 84 revolutions. After the roughing cut, the turret is indexed to bring the finishing tool into

*Copyright, 1907, by Hill Publishing Company.

†Designer of screw-machine tools, Brown & Sharpe Manufacturing Company.

position. The mechanism that rotates the turret maintains a constant speed and the indexing of the turret, to bring another tool to the cutting point, requires one-half second in all cases. With the spindle running 2400 revolutions per minute, each change consumes 20 revolutions. It is an advantage, however, to allow extra revolutions for the operation to facilitate adjusting the dogs that control the mechanism; allowing 22 revolutions for the change will give the desired result.

For the finishing cut, which is 1 inch long, and calculating a feed of 0.012 inch per revolution, 84 revolutions will have to be allowed as for roughing.

The pitch of the thread on the screw being 60 per inch, the number of revolutions required for running the die on the screw (which has a thread ½ inch long) will be one-half of 60, or 30, actual revolutions. To this amount should be added extra revolutions for clearance; allowing 33 revolutions for running the die on to the screw and the same number for backing the die off will give a total of 66 revolutions for threading.

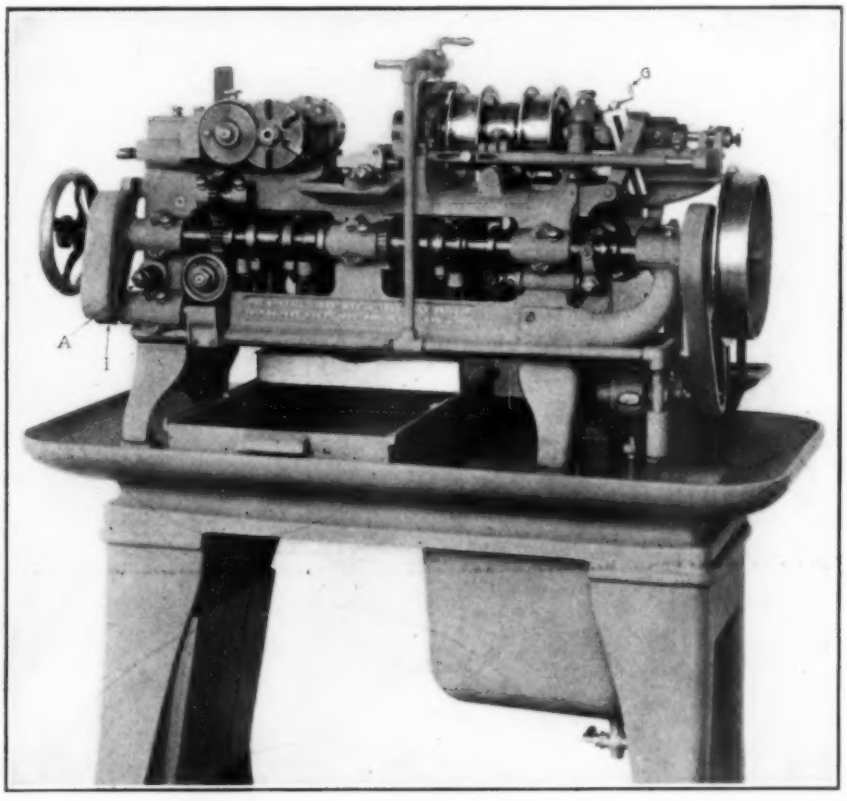


FIG. 2. REAR VIEW, BROWN & SHARPE NO. 00 AUTOMATIC SCREW MACHINE

Spindle Revolutions Required during Cross-slide Movements

A certain amount of the cam circle must be allowed between the threading and cutting-off operations, so that the cross-slide tools will not begin to advance to the cutting point until the die holder has dropped back beyond the interfering point. The drop for each cross slide is 1 inch, giving a distance of 2 inches from edge to edge of the cross-slide tools, with the slides in the backward position.

The die-holder cap with adjusting screws requires approximately 1½ inches space to pass through; as there are 2 inches between the cross-slide tools, should these tools begin to advance to the cutting point as soon as the die reaches the end of the screw (when backing off), there would be a trifle more clearance than actually required.

Consulting the templet shown in Fig. 4, it will be noted that 5 hundredths of the cam circle are taken up in advancing the cross slide from its backward position (which is determined by the low portion of the cam) to the point where the tool commences the cut. The revolutions of the spindle during this clearance can be determined after finding the total revolutions required for the different operations and idle movement.

The cutting-off tool, as shown in Fig. 3, is arranged with a parting blade that has a 23-degree angle on the cutting edge; this is for the purpose of making the parting close to the head of the screw to avoid leaving a large teat on the piece when dropped.

Using an angular blade, it is necessary to allow extra travel so that the low point of the angle can be carried a trifle by the center of the spindle to insure removing the teat on the bar, which is termed "by travel." Add to the radius (0.125 inch) of the bar used 0.019 inch, the amount of "by travel" required for the cutting-off tool plus 0.003 inch clearance, to allow for variations in material, and we have a total of 0.147 inch travel for the cutting-off tool; considering a feed or advance of 0.0015 inch per revolution, approximately 97 revolutions will be required for cutting off.

The facing of the under side of the head (the tool for which travels from ¼ inch diameter of stock to ⅛ diameter of finished size) requires a travel of 0.067 inch, including clearance to allow for variation in material; this cut carried at a feed of 0.0016 inch will require approximately 42 revolutions. As this cut can begin at the same time as the cutting-off operation and will be completed by the time the screw is partially cut off, the revolutions required need not be considered when determining the total number.

Indexing and Stock-feeding Allowance

As there are but four turret tools used in making the screw, it will be necessary to index the turret three times after the threading operation to bring the stop into position for feeding the stock for the following screw. The 97 revolutions allowed for cutting off will give ample time for these changes.

An allowance of 22 revolutions must be added for feeding the stock to the stop after cutting off and indexing the turret to bring the roughing tool into position for the following screw.

The following table shows the total number of revolutions required for actual operations:

	Revolutions.
Roughing cut	84
Index turret	22
Finishing cut	84
Index turret	22
Threading	66
Clearance	
Cutting off (Index turret three times; face under side of head.)	97
Feed stock	22
Index turret	22
	419

As 5 hundredths of the cam circle must be allowed for clearance between the die holder and cross-slide tools, the above total of 419 revolutions represents 95 hundredths of the cam circle. Dividing 419 by 95, the quotient, 4.41 (the number of revolutions in 1 hundredth) multiplied by 100 gives a total of 441 revolutions of the spindle to complete the screw.

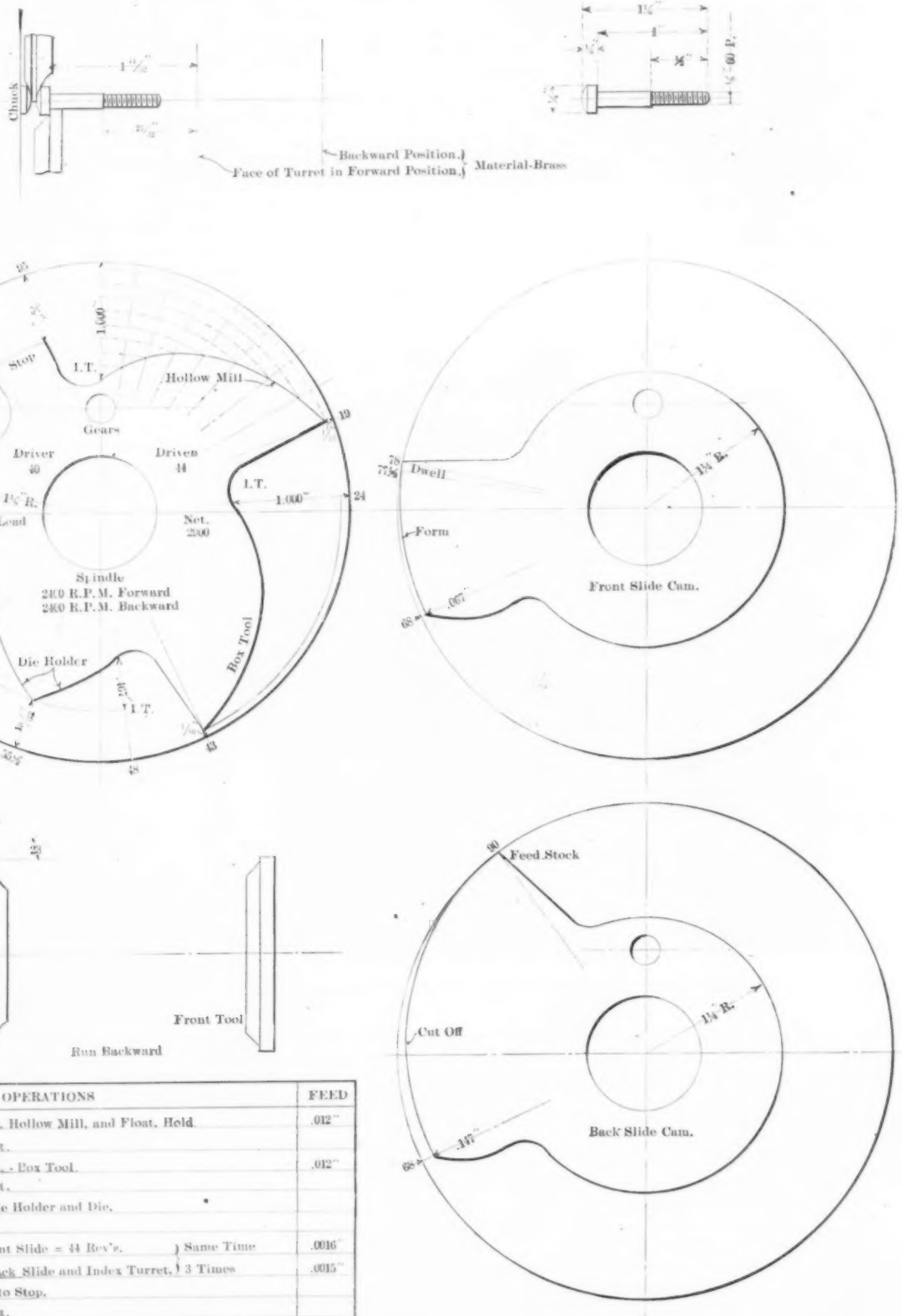
Selecting Change Gears

With each machine a number of change gears are furnished to allow the camshaft speeds to be varied from 3 to 30 seconds per revolution. These gears allow variations of one second to be made. As the spindle makes 40 revolutions per second, selecting a train of gearing from the gear table accompanying the machine that will give a revolution of the cam shaft in 11 seconds, the spindle will make 440 revolutions to one of the cam shaft. It will, therefore, be necessary to take

away a revolution from one of the operations, the total being 441. Allowing 96 revolutions for cutting off, instead of 97, as previously calculated upon, will not make any material difference to the feed for this cut.

Division of the Cam Circle

As it is not convenient to divide the cam blanks into various numbers of parts equal to the number of revolutions required for making different pieces, it is the general practice to divide the cam circle into 100 equal parts, as shown in Fig. 5. The number of hundredths for the lobes and spaces on the cams is obtained by dividing the number of revolutions for each operation by the total number, taking the nearest decimal with



REV'S.	ORDER OF OPERATIONS		FEED
84	Rough Turn, Hollow Mill, and Float, Hold.		.012"
22	Index Turret.		
84	Finish Turn, - Box Tool.		.012"
22	Index Turret.		
66	Thread, - Die Holder and Die.		
22	Clearance.		
	Form, - Front Slide = 44 Rev's.	Same Time	.0016"
96	Cut Off, - Back Slide and Index Turret,	3 Times	.0015"
22	Feed Stock to Stop.		
22	Index Turret.		
440	Total Revolutions.		

FIG. 3. CAM LAY OUT (ABOUT 3/4 SIZE)

two places. For example: The number of revolutions for the roughing cut is 84; dividing 84 by 440, the result 0.19, is the number of hundredths of the cam circle required for the first cut. Reducing the remainder of the operations in the same manner, the cam circle is divided as follows:

	Revolutions.	Hundredths
Rough turn	84	19
Index turret	22	5
Finish turn	84	19
Index turret	22	5
Thread	66	15
Clearance	22	5
Cut off	96	22
Feed stock to stop	22	5
Index turret	22	5
	440	100

A clearance of 5 hundredths has been calculated on after threading to avoid interference of the cross-slide tools with the die holder, in which case the cross-slide cam for cutting off will commence at 68 and extend to 90. The parting of the piece from the bar will occur before the complete portion of the lobe has passed the roll on the cross-slide lever, due to the extra amount of throw on the cam necessary for removing the teat on the bar which has previously been termed "by travel," in which case the stop for feeding the stock can be in position as soon as the cutting-off tool commences to drop back after cutting off. The travel of the facing tool, which commences at ¼ diameter and is carried forward to ⅛ proximately 1⅝ inches from the face of the chuck, with the turret-slide lever on a cam portion 4½ inches diameter.

The Lay-out

On the cam lay-out sheet, Fig. 3, three perpendicular, parallel lines, approximately 1 inch long, should be drawn, with a distance of 1⅝ inches between the first and second, and 1⅛ inches between the second and third lines. The first line represents the face of the chuck; the second, the face of the turret with the lever on a cam 4½ inches diameter; and the third, the face of the turret with the slide in the rear position. A line drawn at right angles through the center of these lines represents the center of the spindle. The cross-

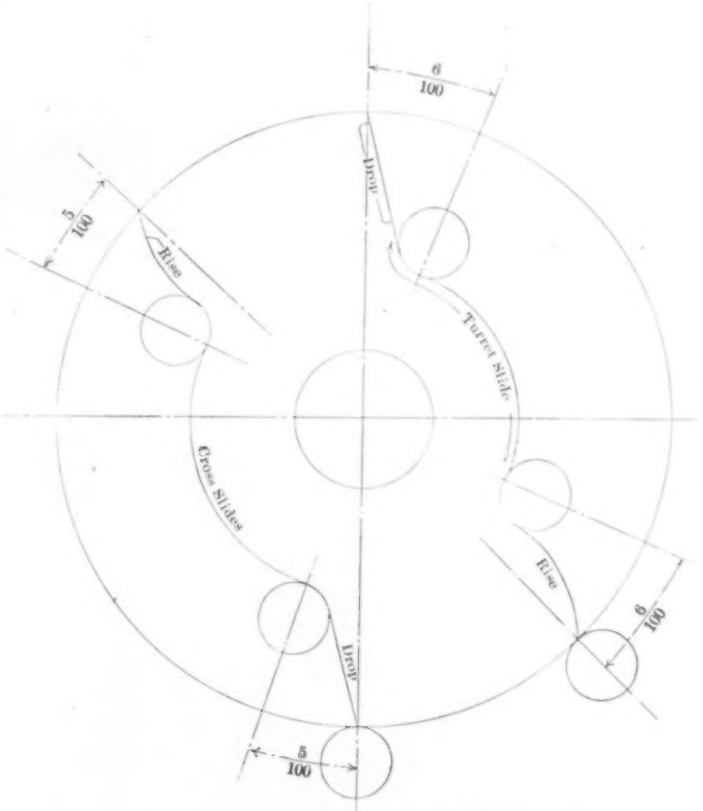


FIG. 4. NO. 00 CAM TEMPLET (ABOUT ¾ SIZE)

FIG. 5. GRADUATED INDEX FOR LAYING OUT NO. 00 CAMS (ABOUT ¾ SIZE)

The Turret and Cross-slide Cams

Commencing at the line opposite the ¼-inch hole in the cam blank, as shown in Fig. 5, the turret-slide cam is divided as follows:

0 to 19, lobe for roughing cut;
19 to 24, space for indexing turret;
24 to 43, lobe for finishing cut;
43 to 48, space for indexing turret;
48 to 63, lobe for threading;
63 to 90, reduced to diameter (2¼ inches) of cam carrier, allowing turret to dwell in rear position during the time taken up for clearance and the cutting off and facing operation;
90 to 95, lobe for feeding stock;
95 to 0, space for indexing turret.

diameter, will be approximately 0.067 inch, including clearance; advancing the tool at 0.0016 inch per revolution, 42 revolutions will be required. To this number are added 2 revolutions for dwell of the tool at the finishing point, making a total of 44 revolutions, which takes up 10 hundredths of the cam circle. As 2 revolutions for dwell will require ½ hundredth, the throw of 0.067 inch will take 9½ hundredths of cam surface.

The facing operation commences at the same time as the cutting off; consequently the spacing of the front-slide cam will be from 68 to 77½ for advance of tool, 77½ to 78 for dwell.

The hight of the various cam lobes is determined by the lengths of the tools to be used. The face of the turret is ap-

slide tools and sample should be drawn to scale close to the chuck line. The line representing the center of the spindle is necessarily the center of the piece to be made. The roughing and finishing cuts are carried close to the under side of the head of the screw. The hollow mill and the head portion of its holder, which extends beyond the face of the turret, is 1⅜ inches long, as shown in Fig. 6; as the under side of the head is approximately 1 11/32 inches from the line, representing the face of the turret in the forward position on a 4½-inch cam diameter, it will be necessary to arrange for the high point on the lobe to stop at least 1/32 inch below the 4½-inch circle on the lay-out sheet, so that the cut will not be carried forward to such a point that the

proper thickness of head cannot be obtained. An extra thirty-second of an inch should be allowed to facilitate adjusting the tool, in which case the high point of the roughing lobe should stop 1/16 inch below the 4½-inch circle; as the rise on that lobe is 1 inch (the length of cut), the low point will be 1 1/16 inches below the 4½-inch circle.

The Turret-slide Cam Lobes

From the zero line to 19 hundredths of the cam circle, construct an increase curve, with a rise of 1 inch for the roughing cut. The method of laying out the increase curve, approximately, is shown in Fig. 3. With a templet as shown in Fig. 4, draw

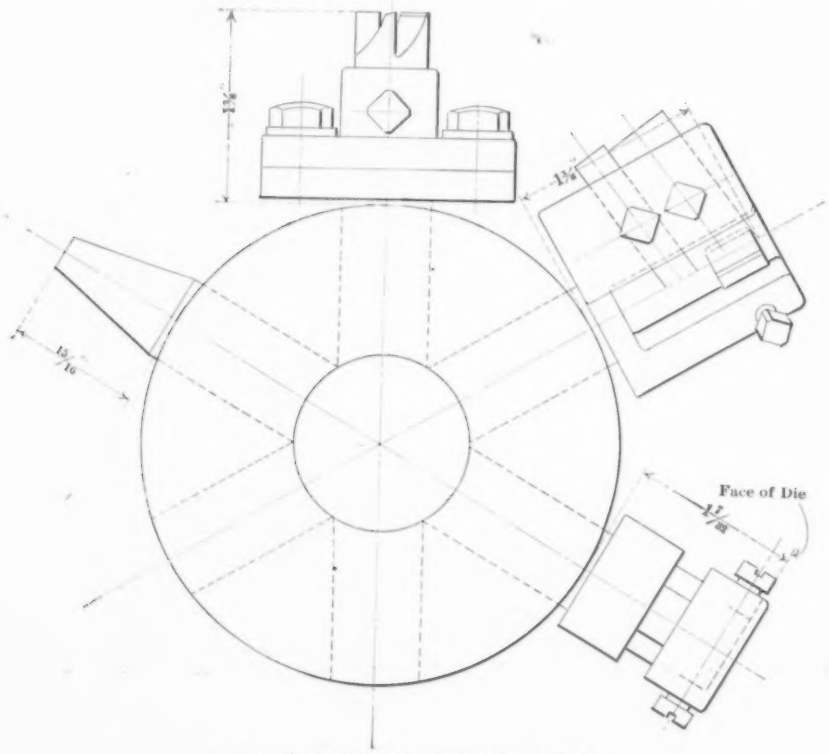


FIG. 6. SHOWING TURRET AND TOOLS

the line of drop, beginning at 19 hundredths, and draw an arc equal to the radius (¼ inch) of the turret-slide lever roll, tangent to the drop line, with the low point of the arc about 1/16 inch below the starting point of the following lobe. The lobe for the finishing cut is a duplicate of the roughing.

In constructing the threading lobes, it is the usual practice to allow the die head, which is arranged to slide on the holder, to draw away from the turret to prevent crowding the die onto the work.

As 33 revolutions are allowed for running the die on to the screw, the advance of the die would be 33/60 (0.537 inch). From this, deduct 0.060 inch to allow the die to draw away from the turret. The result, 0.467 inch, is the rise for the lobe, and the drop for backing the die off of the screw must necessarily be the same.

When determining the hight of the lobe, the amount of "pull out" allowed for the die must be taken into consideration.

The length of the die-holder head, as shown in Fig. 6, is 1 7/32 inches plus 0.060 inch allowed for "pull out." The result, which is approximately 1 9/32 inches is the total length of holder to be considered.

The threading begins at 48 hundredths and requires 15 hundredths of cam surface. The rise for following the die on the screw would be 0.467 inch (7½ hundredths). Locating the high point of the lobe at 55½ hundredths, the length of the holder plus 1/32 inch for clearance makes it necessary to cut the high point 15/32 inch below the 4½-inch circle.

Construct the increase curve for the drop and rise in the same manner as shown in Fig. 3 for the roughing cut.

The die will have backed off the screw at 63 hundredths and the portion of cam surface from this point to the starting point of the stop lobe should be cut down 1⅛ inches from the 4½-inch circle to allow the turret to remain in the rear position during the cutting off and facing operations. Allowance should be made for the drop from the point on the threading lobe and the rise for the stop lobe, using the templet, Fig. 4, for constructing the lines.

The Cross-slide Cam Lobes

The cross-slide cam blanks are 4½ inches diameter. It is not necessary to cut the high point of the lobes on the cams below this diameter when using forming and cutting-off tools, as the slides are arranged with suitable adjustment for producing any diameter within the capacity of the machine.

The rise and drop on the cross-slide cams are constructed from the templet, Fig. 4, and should be spaced in the same manner as the turret-slide cam, using the locating-pin hole for the zero line, in order to time the cams properly when placed in the machine.

The cutting off commences at 68 and is completed at 90 hundredths; the facing is from 68 to 78 hundredths.

Stock Stop, Spindle Reverse, etc.

The stop lobe from 90 to 95 hundredths is without advance to produce a dwell of turret slide while feeding the stock. From 95 hundredths to zero, a drop necessary to bring the turret-slide lever roll 1/16 inch below the starting point for the roughing cut is constructed.

The reversing of the spindle does not consume time enough to make it necessary to allow on the threading lobe for this change. The reversing of the spindle from backward to forward after cutting off can be carried on during the operation of feeding the stock or revolving the turret.

Bright Plated Metal Surfaces

As a rule, articles plated by the galvanic process—that is, in electrolytic baths—have a matt surface. Microscopic examination shows that this is because the surface is composed of minute crystals which disperse the light reflected therefrom even when they are not oxidized. In plating with copper this is especially noticeable. For many purposes this matt surface is desirable—as, for instance, where it is intended to subject the copper to the action of an acid or other solution, in order to give it a patina, or to produce the effect called "blood bronze," but where a bright surface is desired, it is necessary to resort to some mechanical means, such as burnishing or polishing with the wheel, which, besides delaying delivery, increases the cost of production. The same is the case where iron or steel is plated with zinc; furthermore, the hot process is, for many classes of work, not applicable.

A recent German patent refers to a process by which it is intended to produce by electrolytic methods, in baths of ordinary temperature, a bright surface. This is attained by the addition to the bath glykocides, phloroglukocides or other similar substances, or nitrogenous glykocides or their derivatives; or, instead of these substances, the extracts of plants or barks, as, for instance, althea, panama or licorice extract, which contain the substances above mentioned.

The employment of these materials enables the production in the bath, says the patentee, of a brilliant surface on the plated articles, without any mechanical aid. The metal is said to adhere well, so that, for example, zinc-plated iron sheets may be bent backward at will without the zinc coming loose, which up to the present has not always been the case with sheets plated by the hot galvanic process. —*Electrical World.*

Practical Letters From Our Readers

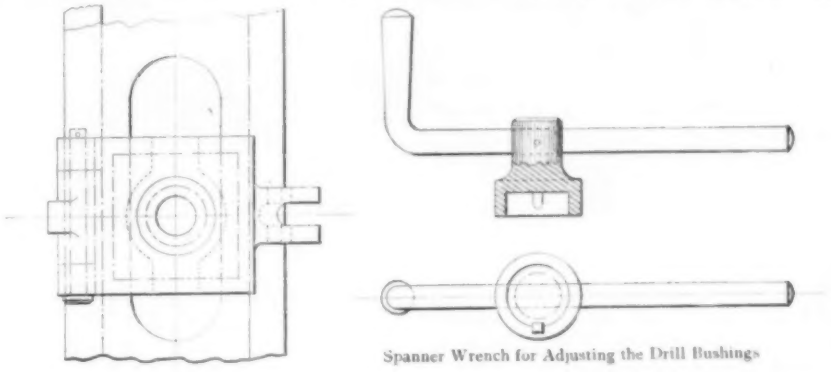
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Self-adjusting Drill Jig

The accompanying line cut and half-tone show a self-adjusting drill jig for balls on hand-rail and deck-rail stanchions, or other spherical work. This jig is in use at the marine department of the Maryland Steel Company. It is designed with the object of insuring that the holes for the rails shall be concentric with the balls and also practically in one vertical plane, even though it may be necessary to alter the spacing slightly on account of variations in the stanchion forgings.

It is constructed on the hinged-box principle, *A* being the upper half which has a tapped hole to receive the drill bushing *C*. The inside is counterbored large enough in diameter to clear the ball to be drilled. *B* is the lower half, counterbored to an angle and depth large enough to seat the ball to be drilled. On the under side of *B* is a shank which projects through the slot in the base plate *D*; on the end of this shank is a square nut *E* which acts as a gib and stop preventing the jig body from turning too far out of position and lifting from the base plate, at the same time being free enough to allow a lateral and longitudinal movement of the jig body to suit the varying center distances of the balls where two or more balls are to be drilled. *C* is a drill bushing of hardened tool steel, notched to receive the special spanner wrench shown; it is threaded on the outside and beveled to an angle of 90 degrees on the lower inside edge, to seat on the ball.



Spanner Wrench for Adjusting the Drill Bushings

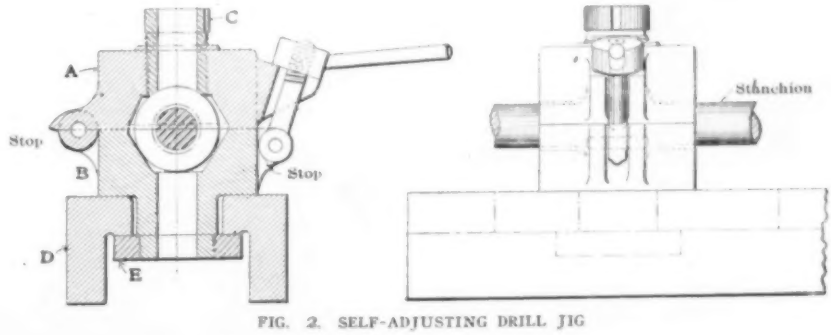


FIG. 2. SELF-ADJUSTING DRILL JIG

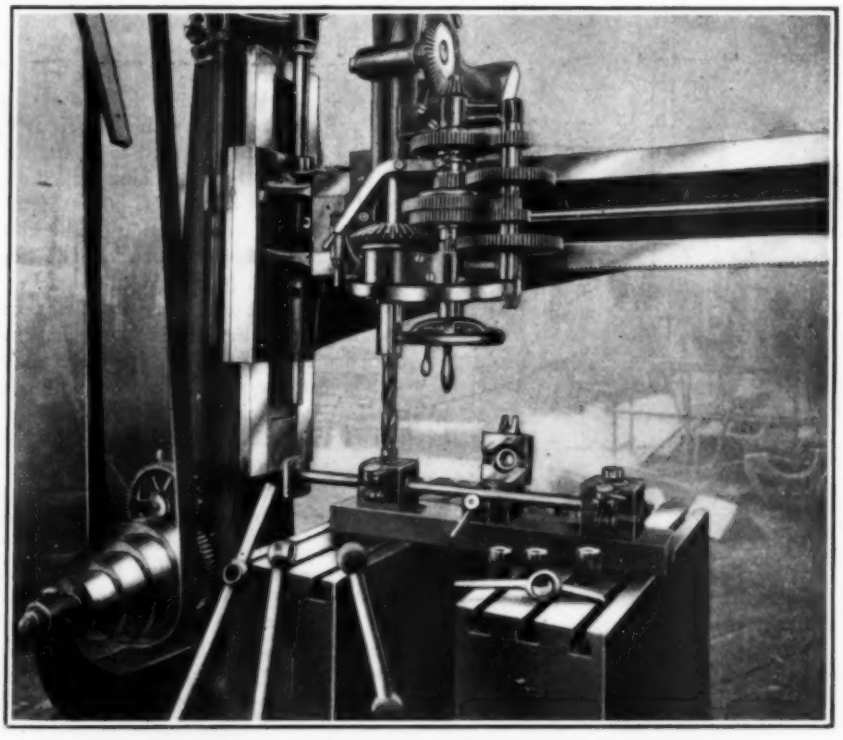


FIG. 1. SELF-ADJUSTING DRILL JIG WITH A SHIP'S-RAIL STANCHION IN PLACE; MIDDLE CLAMP-BOX OPEN

The method of operating this drill jig for a three-ball stanchion, as shown in the photograph, is to unscrew the drill bushing, raise the top half of the jig body or clamping box, insert the stanchion, close the jig and clamp it by the tumble bolt. By this operation the drill bushing is always brought into a strictly vertical position and always in line with the drill. After clamping together the two halves of the box, the drill bushing is screwed down on the ball, centering and clamping the ball by this one operation. When the three balls are clamped by their respective bushings, there is little danger of anything moving out of alinement, and the work leaves the jig as a first-class job.

The slots in the base plate of the present fixture allow for closing in the individual jig boxes or bodies, to drill balls at 8-inch centers; they may be spread out to 13-inch centers. The middle jig body swivels in a round hole in the center of the base plate, the adjustment for center distance being made by the two end jigs.

Baltimore, Md. LEWIS SYKES.

Metal Mold for Oiling Rings

Accompanying this are sketches of a cast-iron mold which I designed and used for continuous oiling rings for crank-pins, etc., and which is very successful, doing away with all skilled labor on the job. The rings are ready for use as soon as they leave the molding shop, when they can be either painted or polished, having a finished appearance either way.

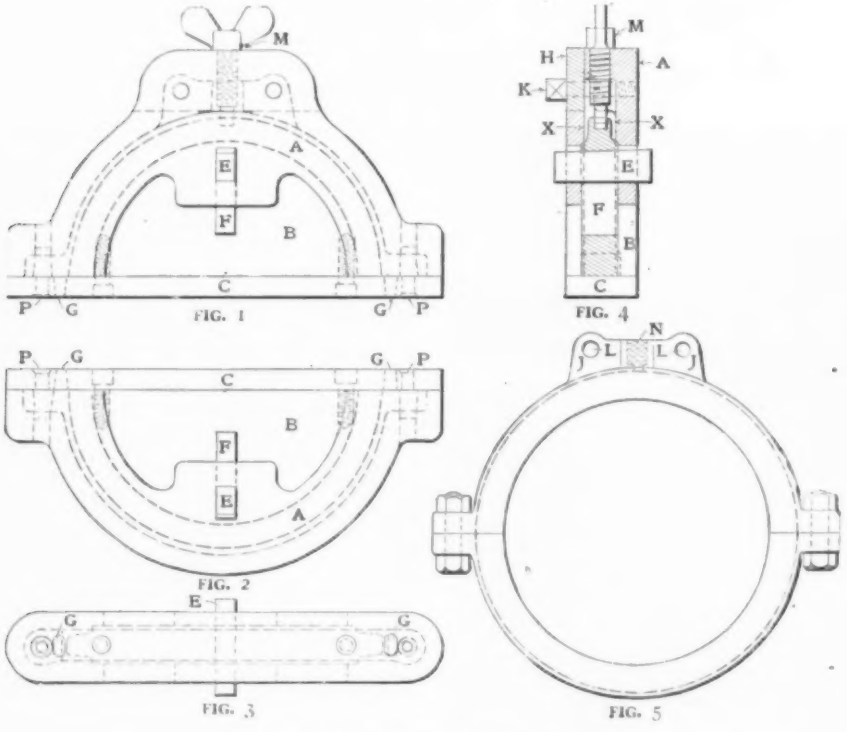
Fig. 5 shows the completed ring made in halves to enable it to be fitted after the crank-shaft is in place and also to allow it to be used in cases where the crank web comes close up to the bearing, in which case it revolves outside the bosses and could not be put in position in one piece.

In Figs. 1, 2, 3 and 4 *A* is the cast-iron mold; *B*, cast-iron core; *C*, mild-steel core plate to carry cores *B* and *D*, and also to close the mold. *E* is a cotter to hold the cores in position; by reversing it and driving through opening *F*, it can be used for withdrawing the cores after pouring. Holes *G G* in core plate *C* are for pouring, a flat-bottomed funnel being placed over them when in use.

Mold *A* is cut away, as shown at *H*, to enable recesses in the mold for ears *j* of the ring to be machined. It is made up with a loose plate, as shown, held in position by tap bolts *K*, which also act as cores for bolt holes *L* in the ring. *M* is a screwed core for hole *N*, which is threaded 26 per inch for a brass connecting pipe. We found the cast threads better than tapped ones, as the white-metal mixture used for these rings was rather soft and inclined to tear.

Cores *P* for the joint bolts were slightly tapered to facilitate drawing, as also were the sides of the mold marked *X*, Fig. 4.

After trying various aluminum alloys, which were not successful owing to the contraction pulling the lugs off at *R*, we used a white-metal alloy containing a large percentage of lead, to keep the cost down.

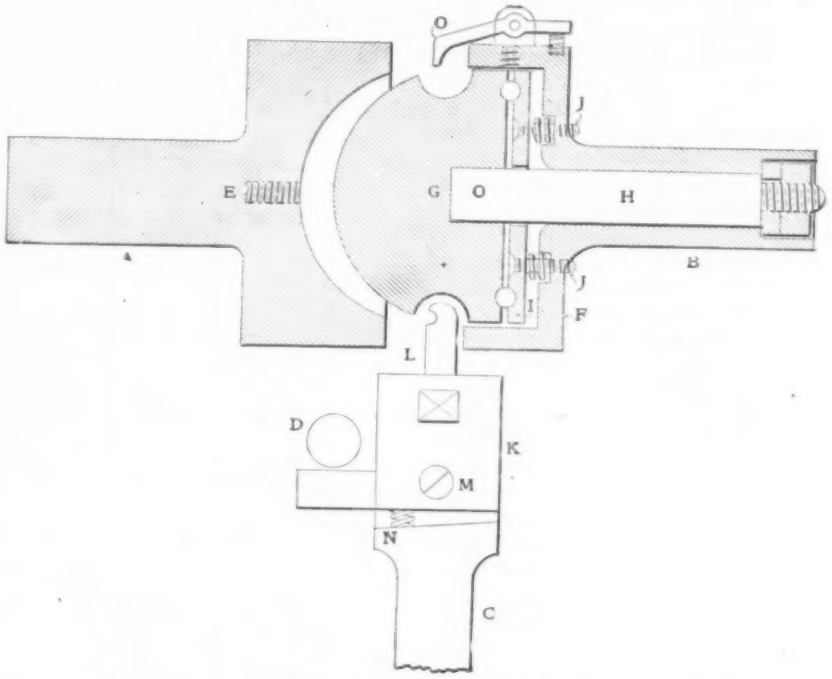


METAL MOLDS FOR CASTING OILING RINGS

England. W. J. Brown.

Turning the Edges of Gongs

Some time ago we had a very large number of gongs that had to be trimmed rounding on the edge. We first tried using a chuck like *A* with a screw let in at



TURNING THE EDGES OF GONGS

E, which went through the hole in the gong and was clamped by a thumb screw or nurled nut. But on account of having to turn so large a diameter on so small a screw, they kept breaking off. So the toolroom foreman took the matter in hand and designed the tool shown. *A* is a chuck turned on the shank to suit any split chuck available, in this case it was 1 inch, the hollow in the front to suit the gong. *B* is turned to fit the turret, also 1 inch, the body being drilled and bored to receive *G* and *H*. *G* is of tool steel, turned to fit the inside of the gong and has a ball-race at the back. The stem *H* is a tight fit, pinned in *G* at one end and threaded at the other to take a nut and keyed washer, which prevents nut from backing off. *I* is a cast-steel plate, with a ball-race to correspond with that in *G*. It is carried on four retaining screws with spiral springs *J J*, which hold the plate up to *G* and prevent the balls from falling out. *C* is a toolholder and tool which is held in the cross-slide tool-post. It has a loose plate which carries the tool *L*, the plate being pivoted at *M* and held back by the spiral spring at *N*. *D* is a pillar fixed by a clamp to the bed of the lathe to the left of the cross-slide, the operation of the tool being as follows: Place a gong on *G*, it will be held by three small clips *O*; bring the turret up till *G*, with the gong on it, comes in contact with *E*, which is running for-

ward; now put on a little pressure. *G* will revolve, at the same time it will force *I* back against *B*. Now advance the cross-slide with the tool and toolholder *C* till the lug on the plate *M* comes in contact with the pillar *D*. This will swing the tool *L* against the work, trimming the edge and putting the round on the edge, sufficient pressure being kept on *G* to drive the work while cutting.

London, Eng. J. V. HOXLEY.

Alleged Modification of Halseys' Premium Plan

In the article by C. L. G., page 287, AMERICAN MACHINIST, occurs the following, "a modification of the Halsey system—the modification providing that I was to receive a decreasing percentage of the saving instead of a fixed percentage."

It is not clear to me in just what way Mr. Halsey's system is modified. If in the diagram herewith submitted, line *C D* is supposed to represent time, line *A C* money, line *C B* will represent day work and line *A B* piece-work.

In Vol. XII., *Transactions* of A. S. M. E., Mr. Halsey describes a system of paying for labor, devised or invented by himself, which he calls the premium system; a careful reading will disclose that, broadly, he covers a method of payment that for increased production is more than day work, but less than piece-work, and without any forfeits or deductions.

It is evident that this system is represented by the triangle *A B C;* if savings are divided equally between workman and proprietor, it can be shown by a straight line, as marked 50 per cent. premium.

On page 842, Vol. 22, an article was published in which payments are based on the curve *F;* but since this curve is inside of the triangle, and consequently in all essentials Mr. Halsey's system, no originality was claimed for it, merely the method of accounting.

Sixteen months later, or on page 49, Vol. 25, another article on the premium system was published, with payments based on the curve *E*, but with the difference that here everything in sight is claimed. As that curve is within triangle *A B C*, the absurdity of such claim is apparent.

The curve *G* is based on figures given by C. L. G. in his article; while it is lower than the others, it is within the triangle. I fail to see that Mr. Halsey's system is modified even a little bit.

So long as we draw lines, no matter what shape, inside that triangle, we are merely erecting tents on Mr. Halsey's ground and no originality can be claimed, except perhaps in the manner of accounting.

Chicago, Ill. FERNSTROM.

FIG. 1

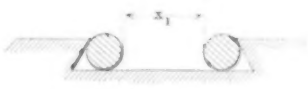


FIG. 3

FIG. 2

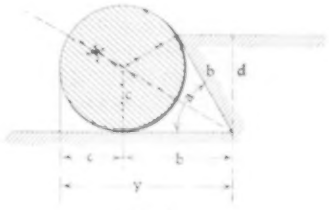
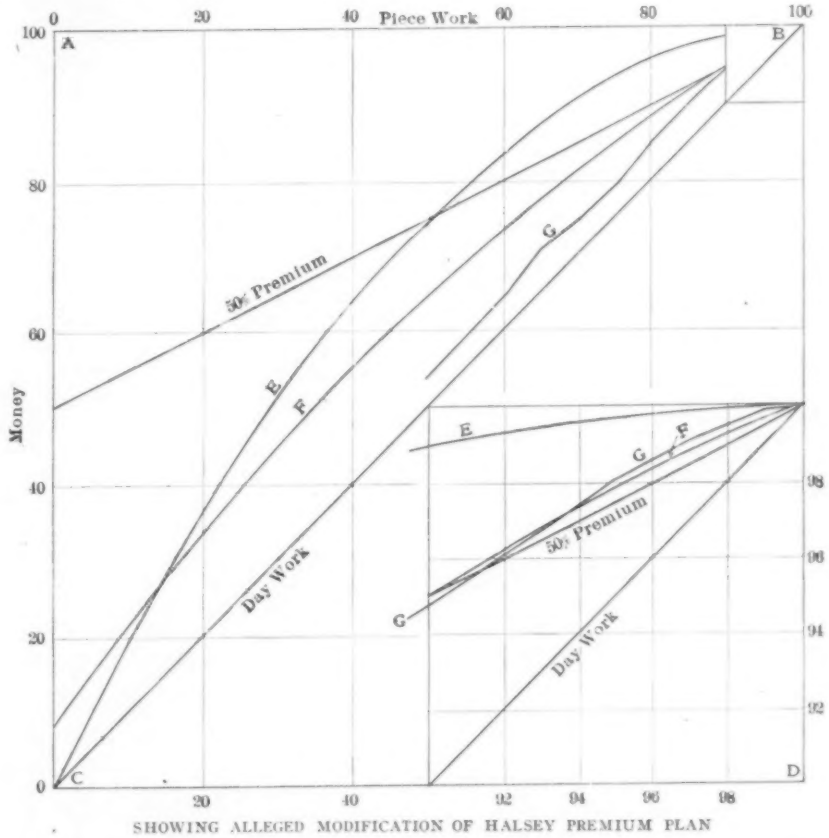


FIG. 4

MEASURING DOVETAILS



SHOWING ALLEGED MODIFICATION OF HALSEY PREMIUM PLAN

Measuring Dovetails

A short time past, in the manufacture of parts of gun mounts we found it necessary to adopt some method whereby we could measure widths of male and female dovetails that had to be machined so as to leave as little fitting as possible after the machining operations. The inspection on these pieces was very thorough, and the pieces had to be first-class fits in order to pass the inspection.

We first tried measuring across the points w and w_1, Fig. 1, but found this method not satisfactory because the milling cutter could not be depended upon to make the apex of the angles perfectly sharp. After a little consideration we decided to try laying a piece of wire in each angle of the dovetail, as shown in Fig. 2 for the male and in Fig. 3 for the female, measuring the dimension x across the wires for the male and the dimension x_1 between the wires for the female.

The method proved to be highly satisfactory, and it occurred to me that the idea might be equally useful to other readers of AMERICAN MACHINIST, especially toolmakers, when called upon to make up gages for male or female dovetails; I therefore hand it out for what it may be worth.

To find the value of y and the diameter of maximum wire that may be used with a given dovetail, we proceed as follows: Referring to Fig. 4, by inspection it will be seen that $b = b$ and $c = c$.

Let d = depth of dovetail and a = angle of dovetail.

Then $b = \dfrac{d}{cos.(90° - a)}$ and also $= b$.

Also $c = sin.\ \dfrac{a}{2}, \times b$ and $2c$ equals di-

ameter of maximum wire that may be used with a given dovetail.

After having decided upon the size of wire that will be used, we must find the value of y, Fig. 4, for the given dovetail. Letting c = radius of wire section, we find $b = \frac{c}{\tan. \frac{a}{2}}$ and $y = c + b$, or $= c + b$. It is readily seen by referring to Figs. 1 and 4 that the dimension x, Fig. 2, equals $w + 2y$ and the dimension x_1, Fig. 3, equals $w_1 - 2y$.

The above may not be new to a great number of the readers of AMERICAN MACHINIST, but it should be helpful to some yet as it has been to us.

Bridgeport, Conn. WALTER CANTELO.

A Wire-bending Fixture

The accompanying illustration shows a fixture for bending pieces of steel wire of about ⅛ inch in diameter and 10 inches length to the shape shown in Fig. 1. Although the work is to be bent in two places, and the directions of the bends are to be opposite, both of these bends can be made at one setting.

Referring to Fig. 2, A represents the base of the fixture, and at B, in Fig. 3, is shown a downward projection of this base, so it can be held in a bench vise. In Fig. 2 C shows a machinery-steel block, screwed and doweled to the base A. The sides D D' of the block C serve as a form against which the work is held, on the side D'; it is shaped on the side D.

The block E, Fig. 2, clamps the work against the part just described. It is actuated by the eccentric F in closing, and by the springs G in opening. H is a machinery-steel form, pivoting on the center I and receiving its radial movement from its connection with the lever J, which is located on the under side of the base. This lever is locked while in duty by engagement of latch K with a notch in the block L. The dot and dash lines show the form and its lever in the locked position. The full lines show their position before the operation is started. The shape of this form where grooved corresponds with that desired for the finished work. The lever M, Fig. 2, carries a tool-steel roll N, and pivots concentric with radius on form H, when this form is in the locked position.

To operate the fixture the block E is released by a turn of the eccentric F; the form H is brought to the position by full lines, and the roll-carrying lever M moved to the position also indicated by full lines. A piece of work is placed in the fixture, located against the set-screw O and in the groove in the side D' of block C. As shown, the roll N and the form H are also grooved slightly. The jaw E is now closed upon the work by a movement of the eccentric F. The block H is then swung to its locked position, shown by dot and dash lines, after which the lever M is swung around until it stops against the set-screw P. The roll N, traveling with this lever, causes the work to lie closely against the form H.

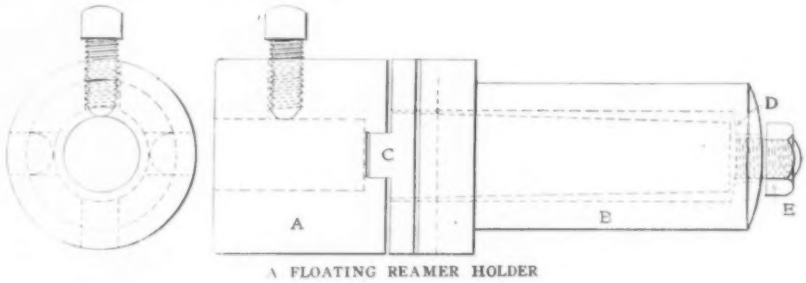
The work as it appears when first placed in the fixture is shown at W. W' shows the work after having received its first bend and W'' shows the work after having received its second and final bend. This fixture is now producing very good results in a shop devoted to the manufacture of an extensive line of machine tools.

Indianapolis, Ind. D. R. STAMAN.

An Inexpensive Floating Reamer Holder

Recently I have had occasion to go into the question of floating holders, and have found the floating principle in all of them defective in one or more particulars.

A reamer will not float when under the driving strain if the part A is held from turning in part B by two pins or projections in part B, for even though there is plenty of play between the shank of A and the hole in B, the holder A will always stop in a certain position when the driving strain is applied. Neither will it float if the back of A rests flat against the front face of B, for should the turret be locked out of alinement with the spindle, when the reamer is started in the hole, A will bear against one side of B, and when the turret is fed forward there will be a tendency for A to rest flat on B. This will tend to throw the reamer out of alinement, and a taper hole will result. This is a bad feature of the one shown on page 46.



A FLOATING REAMER HOLDER

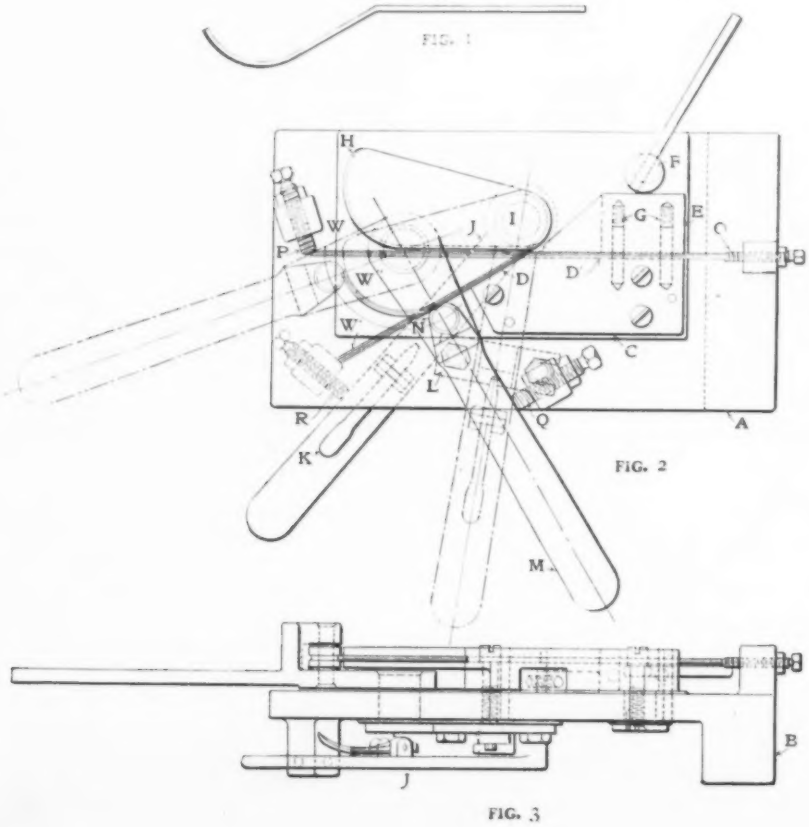


FIG. 2

FIG. 3

Another defective "floater" is the one with a fixed center at the rear end of part B. While this overcomes the fault in the previous one, it prevents the holder A from floating into its true position if for any reason the center of the turret should be out of alinement with the spindle.

In the holder shown herewith, I think all the above mentioned defects are overcome. The "equalizing driving clutch" allows the part A to maintain its true position when the driving strain is applied. The back of A is prevented from

resting flat against B by the shank of A resting against the rear of B, at D; this being rounded allows it to accommodate itself to the true position. The nut E prevents A from pulling out of B when the reamer is withdrawn. Unless the reamer is very large, the weight does not cut any figure. This style of holder is especially adapted to work where a taper reamer is used, and the hole must be an exact taper.

Philadelphia, Pa. E. A. ERMOLD.

[The equalizing clutch is the Oldham coupling, which has been used for many years in power transmission, but we have never before seen it applied to a floating reamer holder.—EDITOR.]

Elimination of Friction in Ball Bearings

Under this heading there is an article on page 119 of the AMERICAN MACHINIST. As one actively interested in the design, manufacture and exacting use of ball bearings, I may be permitted to call attention to a few points concerning which I cannot quite agree with the author of the article.

That "the experimental stage is rapidly being passed" is not in accord with the situation as concerns the ball bearing itself. When an engineering element has arrived at the point where one firm has a daily output of over eight thousand bearings and a steady growth during ten years, it is hardly in order to speak of an experimental stage.

The article in question has an illustration, Fig. 5, reproduced here as Fig. 1. In it a small ball is inserted between the larger ones. The larger balls are in contact with the races and carry the load. The small balls are introduced merely to bring about rolling contact between the balls, instead of the sliding which would otherwise take place between load-carrying balls in contact, as in Fig. 2. This is true enough, but the use of the small balls is nevertheless a decided error

FIG. 6

FIG. 7

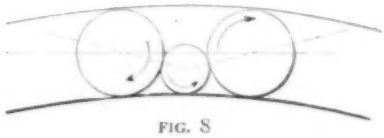


FIG. 8

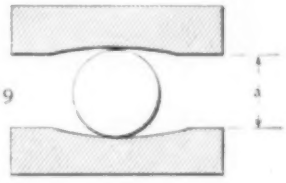


FIG. 9

FIG. 10

ELIMINATION OF FRICTION IN BALL BEARINGS

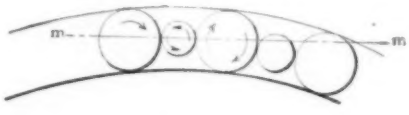


FIG. 1

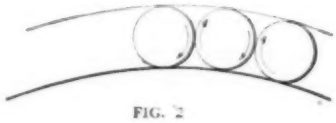


FIG. 2

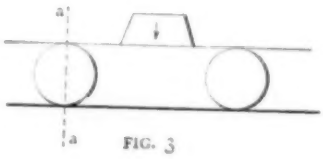


FIG. 3

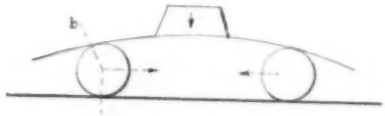


FIG. 4

FIG. 5

ELIMINATION OF FRICTION IN BALL BEARINGS

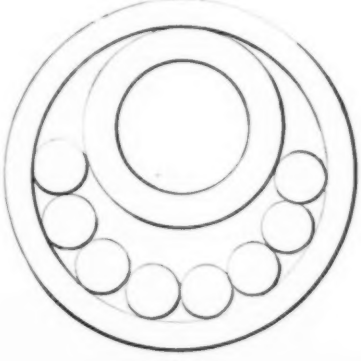


FIG. 11

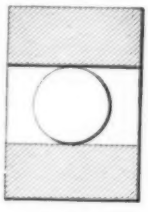


FIG. 12

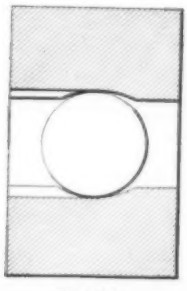


FIG. 13

ELIMINATION OF FRICTION IN BALL BEARINGS

Though there is sliding contact between the balls in Fig. 2, it could only represent a frictional loss of real moment were there to be pressure between the balls due to the load carried by the bearings; but the load carried does not cause pressure between the balls of a ball bearing. The proof is simple. Consider Fig. 3. Here two rollers or balls are inserted between parallel planes; it is certain that so long as the planes are parallel the rollers or balls will neither be forced toward nor from one another, no matter how heavy a load is placed on the upper plane. Note that the contact points $a\,a$ of the balls with the two planes are at opposite ends of a ball diameter.

Consider Fig. 4. The upper plane is now bent out; clearly the rollers or balls will be forced toward one another under the influence of the load. The contact points $a\,a$ between the balls and the top and bottom plate are no longer on the same ball diameter, but on $a\,b$.

Consider Fig. 5. The upper plane is bent in; it must be apparent that the balls will be forced apart. Here again the contact points between the plates and the balls are no longer on the same ball diameter, but on $a\,c$. It follows clearly enough that, if the rollers or balls between parallel surfaces are not forced toward or from one another, there can be no pressure between such rollers or balls due to the load carried.

It has been shown that: (*a*) When the

ball and support contacts lie in the same diameter, the load has no resultant force tending to displace the balls bodily. (*b*) When the ball and support contacts lie in different diameters, the load has a resultant force that does tend to force the balls together. In case (*a*) there can be no pressure due to the load between adjacent balls. In case (*b*) there is such a pressure.

The two parallel planes of Fig. 3 may be imagined as being circular arcs of infinite radius. Fig. 2 differs from Fig. 3 only in the races being arcs of smaller radius. The relation of the contact between the balls and the tracks or races is the same, since in both arrangements these contacts lie in the same ball diameter. It has just been proved that under that condition the load has no influence tending to force the balls together; there is, therefore, no need of provision for the insertion of the small balls of Fig. 1; the latter are useless because they are intended to correct the consequences of a condition which does not exist.

The inventors of the interposed small ball idea have curiously overlooked the fact that the arrangement must really fail of its object even were their notion of the adjacent balls being under pressure correct. The trouble is that they do not carry their analysis far enough.

In Fig. 6 is shown the plan-view relationship of two balls and the interposed small ball along the line *m m* of Fig. 1. So long as this small ball is exactly centered between the other two, so that their three centers lie in a straight line, everything is fine; but let there be the least vibration while running, and the small ball will go to one side, as in Fig. 7. It will be immediately wedged outward still more under the influence of the pressure between the balls. To stop this action the small ball is carried in a cage which prevents much side displacement; but, as it is wedged sidewise against that cage, sliding friction is at once set up between it and the cage. However, that is not the only error of the construction. If the small ball in Fig. 1 lies exactly central between the two large ones, it will not be wedged, either outward toward the outer race nor yet inward toward the inner race. But let there be the slightest jarring and at once this small ball will move outward toward the outer race where it has more room. If a cage is provided, to prevent this movement, the ball will be wedged against that cage and slide on it. If, to dispense with the cage, the small ball is made small enough, as in Fig. 8, so that its center lies below the line connecting the centers of the two large balls, then it will be wedged against the inner race, and will, as is shown by the direction arrows, actually roll in the wrong direction on the inner race, to the manifest detriment of the bearing.

On page 335 of this journal will be found other matter in proof of the fundamental error involved in constructions, involving the interposed ball, such as those of Fig. 1.

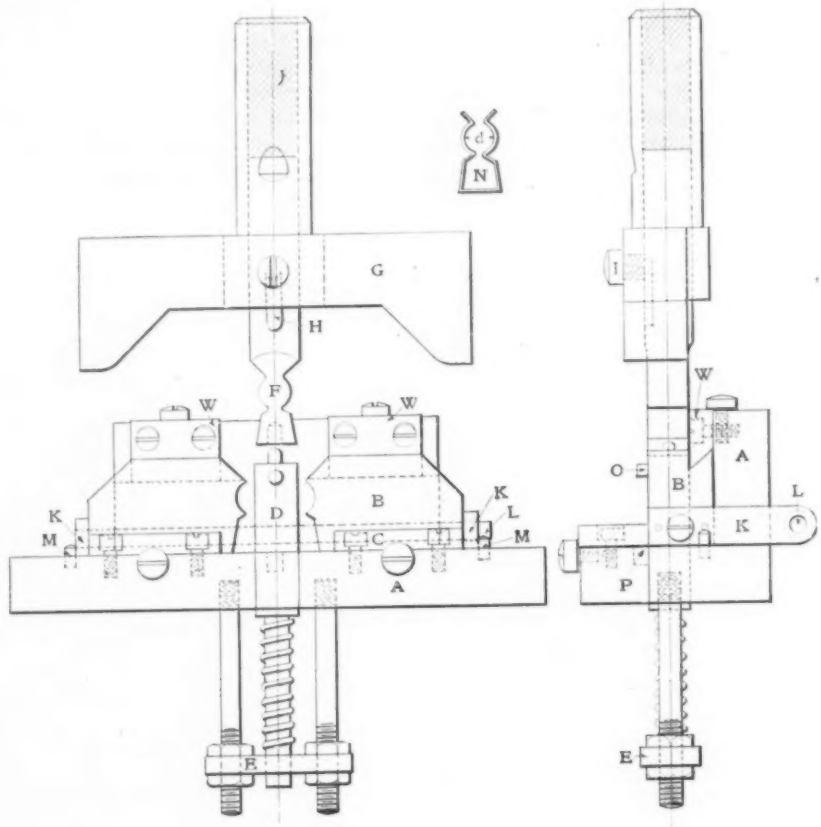
In Mr. Springer's article it is further said: "A separating device which does not roll would have but little effect, apparently, as the slide would still remain." As it has just been shown that the load causes no pressure between adjacent balls, and that, therefore, there can be none on the elements separating these balls, it is immaterial whether the separators slide or roll.

The *H B* or *D W F* ball bearing is very widely used and is represented in cross-section by Fig. 9, and in elevation by Fig. 10. It will be seen that the space *a* between the races is too narrow to admit a ball and that no cut or other opening is provided for introducing the balls. The method of assembling is illustrated by Fig. 11. Enough balls are placed around the outer race to half fill it; the inner race is then brought in eccentrically and pushed down; the balls are then distributed and held in place by separators to form the finished bearing of Fig. 10. The object of the separators is to permit the use of races that have absolutely unbroken cross-sections throughout their entire circumference. The desirability of maintaining this uniformity of cross-section is found in the fact that a cross-section such as Fig. 12 has only about one-third of the load-carrying capacity as that of Fig. 9. Cutting a groove in the side, as in Fig. 13, to admit sufficient balls to fill the outer race results in a local section having the low carrying capacity of Fig. 12. As the strength of any element is only that of its weakest point, the carrying capacity of the bearing without separators is seriously diminished.

Philadelphia, Penn. HENRY HESS.

A Spring Forming Tool

A job we had recently was to form the spring of which a side view is shown by *N*. It was used for gripping cartridge-shaped fuses in electrical fittings, the diameter *d* being about 6 millimeters. The blanks were first pierced and blanked from 0.6-millimeter german-silver strip stock, the ends being slightly round and the sides of the blank being parallel for its whole length. As a good number were required, it was necessary to do the operation of forming in as few stages as possible; this led to a tool being made in which the springs were formed by one stroke of the press; the principal points of it will be understood from the accompanying drawing.



A SPRING FORMING TOOL.

The base of the tool was shaped from a piece of thick angle steel *A*. In the center of this base is a square hole into which the spring pad *D* fits closely, but yet slides freely, steadiness being secured by means of the lower cylindrical portion working through the plate *E*, which is

secured by nuts upon the stems projecting from the base. Fitted to the base are guide pieces *C*. The two forming dies *B* work in these guides, the two inner ends of the dies being shaped to the external shape of the spring to be made, and the two outer ends being shaped to a 45-degree incline. Fixed to the outer ends of the dies are lugs *K* projecting back behind the vertical part of the base *A*, as can be seen in the side view. One of them has a steel rod, shown dotted, fixed to it at one end, the opposite end of the rod projecting through a clearance hole in the lug of the other die. A helical spring, not shown, is fitted over this rod and presses outward against the lugs, thereby keeping the dies extended to their correct position, which is fixed by the pins *M*. The top sides of the dies are dovetailed and held in place by the top guides *W*, adjustment for wear being provided for by the screws. The vertical and horizontal guides prevent the dies moving except in their proper direction.

The dies are actuated by means of the 25-degree inclined parts of *G* coming into contact with those on the outside of the dies, a further downward movement of the ram which carries the part *G* causing the dies to move inward and close upon the former punch *F*. This punch *F* is a close-sliding fit in the shank of *G*, rotation being prevented by means of the fillister-headed screw *I*, projecting into the slot *H* in the punch. The upper part of the bore of the shank *G* is packed with flexible rubber *J*, which keeps the punch out to its full extent.

Operation of the Device

To form the spring the pierced blank is located over the pin of the spring pad *D*, the back guides preventing the blank turning on the pin. The ram of the press is brought down, the punch *F*, its holder *G* and the pad *D* moving together until the pin *O* comes to the bottom of the groove *P*, shown dotted, in the base, thereby forming the blank into a U. Now as the punch *F* cannot move any farther, a continued movement of the ram will cause the rubber to be compressed and the dies to move inward by the 45-degree inclines moving over each other, thereby pressing the U-shaped blank onto the punch *F*. As the ram is taken up, the dies recede, when the spring can be slipped off the punch. The base *A* was case-hardened and lapped on the wearing surfaces; the remaining parts, which were of tool steel, were hardened and tempered.

London, N. W. Maddison.

A Handy Micrometer and a Rubber Cutter

If you want a micrometer with which you can get into places that you can't with any other, you will find one like Fig. 1 very handy. Having a great deal of estimating to do in small metal pieces, I found myself handicapped more than once, especially when not allowed to cut the sample. The outcome was I had a pair of micrometers made with points coming directly together and the bottom cut off so as to use inside a shell if necessary.

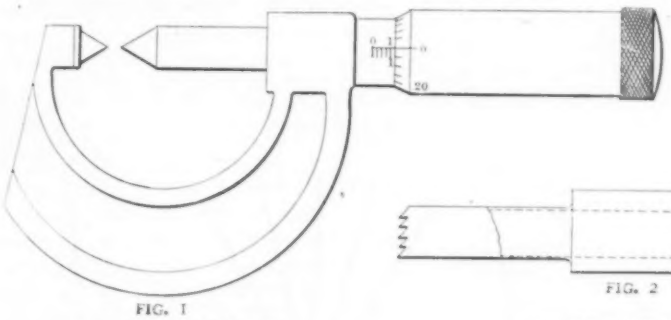


FIG. 1
A HANDY MICROMETER

Reamer for Soft Rubber

I had to put some holes in soft rubber about ¼ inch diameter, the rubber being ½ inch thick, and I am inclosing a sketch of the reamer I used. It will cut fast and leave a smooth hole if run at the proper speed, the speed to be governed by the hardness of the rubber. The reamer is made from tool steel with teeth filed in and not hardened. This may be an old idea, but I have never seen it used before.

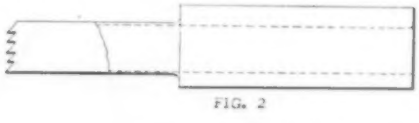


FIG. 2
A REAMER FOR RUBBER

Hartford, Conn. George Addington.

Proper Shop Training—A Result of the Natural Method

Mr. Cardullo's article at page 442 reminded me of my experience in a school shop. This was quite a few years ago, before it was discovered that a shop might be made a laboratory and before so much scientific effort had been expended in devising methods of instruction. This school shop came pretty near being a simon pure machine shop. The instructor and foreman was a genuine machinist. No college degree ever got near him, but when it came to machine work he could do it; and when he felt inclined, he could show us how. Sometimes he felt like showing us and sometimes he did not.

He contrived to form the impression that I was no good at the machine business, and being no good he did not give me much except what Mr. Cardullo calls the natural method of instruction. Once he did condescend to tell me that if I would tie a string to a shaft that I had centered (?) that when it went out the window I could follow it more easily. One day he gave me a job which needed a piece of ⅝-inch square stock about a foot long. There was a bar about 12 feet long on the rack, but no short piece. I asked him what I should do about it.

"Cut it off, of course."

"How?"

"Oh, any way you please; there is the screw machine."

Yes, there was a screw machine. I shoved the bar through the spindle; had to change chucks before it would go through. Then it would not go through far enough because of the tools in the turret. I took out a tool, found that did not give enough room even when the turret was clear back on the bed. So I started to take off the turret. Mind you, the foreman was only a few steps away, taking in the whole thing. I took out the bolts and gave the thing a heave and found it was heavy. I looked over toward the boss, but just then he was looking the other way with the sort of a grin on his face that would have made me pull off that turret alone if I had died on the spot. I got it off. It was about the worst thing I could do for my own good, and he knew it; but all the consolation I got was that he thought it was "astonishing how little some people could know and still live."

And that was the way it was for three long years. Did I get mad? I did. I walked the streets many a night till one o'clock in the morning, trying to get my nerves down where they would take me into the shop the next morning. When I got through he told me he was surprised and that I deserved credit for sticking it out even if I had no mechanical ability. Now that was the natural method done to death. I would not go through that experience and swallow everything so like a dog as I did again for any money, but it did give me something that has been worth a lot of money since.

I went out of there right into a shop to work at bench and lathe; I never had any trouble holding my end up, and I never had my "tech" origin thrown at me after the first week. It was not the particular things that I learned to do in the school shop that helped me; the practice in the two shops was as different as it could well be. What did me the most good was the learning that I must *think for myself* and find out for myself. I think that boys can be taught these things in a manner that will leave them more respect for their teacher, but the method used on me was effective, to say the least.

Boston, Mass. Con Wise.

Distortion of Steel in Hardening

I have noticed what has been printed recently pertaining to the contraction and expansion of steel in hardening. I do not know that I can give your readers any great help, as it is almost impossible to tell whether a piece of tool steel will expand or contract until it has been hardened and laid before you. I will say this, however, in regard to thread-gage plugs and taps or any piece of their general shape: they are bound to get larger and shorten when hardened in the ordinary way. They cannot get shorter without getting larger, and they cannot get larger unless they shorten. The cause of this is from the fact that the piece cools first on the outside, which then contracts and distorts the inside. As the cooling continues, it contracts more and thus continues to distort.

I should be afraid to hold a piece of this kind in my hand; a piece which had not gone out of shape to an extent measurable with the micrometer. Such a piece would have an internal strain that might throw off some part of the outside with great force. There is but one help for tools hardened in the ordinary way to keep them from expanding, and that is by cooling the outside so fast that enough of it is cooled and hardened to prevent the inside from distorting. This, of course, is hard to do, and very seldom accomplished; but it will at any rate be better than cooling the piece slowly.

Now a point in reference to ring gages: Some complain that they expand. My explanation of this would be as follows: First, the ring gage is thin, say one-eighth inch or one-fourth inch in thickness. Of course this piece can be and usually is cooled very quickly. This produces just the opposite results to what would take place on a plug. It has more than twice the cooling surface of the plug. Thus it can be cooled quicker than the plug. The result is that it cools rapidly on the outer surface and, being so thin, when it does cool it has not sufficient power within itself to distort.

I have taken a piece of 0.114-inch stubbs steel 7 inches long, cut it into two pieces, and hardened one piece and found it had not changed in the least. Then I heated the second piece and found it had bulged 0.001 inch and had gotten 0.002 inch shorter. Apparently there is no set rule that can be followed, unless it is to be found in pack hardening.

There are several things that should be guarded against in doing this work, and then 0.002 inch will be sufficient for lapping on the gage ring. First, the ring gage, if possible, ought to be heated in the same manner as if it were to be pack hardened, then it should be cooled in water. When this method of heating cannot be used, the gage, if heated in an open fire, should be heated very slowly and evenly. If heated in a lead bath it should not stay in the lead longer than 50 seconds, providing the ring is of the size mentioned. Then these rings should not at any time during the heating and hardening be held with the tongs. Take a light wire and loop it on the ring, making an eye for a small rod. The ring can be handled in any way desired and the method of holding will not interfere with the hardening and cause a soft spot where the tongs touched. The strain should be well relieved before starting to lap such a ring. In making ring gages of larger size, it is much better to allow plenty for grinding and then lap to size.

Now as to the hardening of the gage plug: If the plug is heated in a forge or gas fire, care must be used to heat it evenly, being sure not to get it too hot, and also being sure to have it free from all dust. There is one thing I wish to mention before proceeding farther, and that is that all tool marks caused by the feed should be removed before the piece is heated. It is not necessary to have a polished surface, but it is necessary to have the plug moderately smooth, in order to color as it should. Plunge in cold water, no matter if there is ice in it; it must be cold. If possible, put it into a stream of water; in fact, cool it as quickly as possible. I do not say that this plug will be ready to be lapped, but as a rule it will not distort as much as one which is cooled slower; neither do I claim that this is the way it should be done. Let us consider a thread-gage plug and its proper handling. First, it should be made as short as possible. Of course it will not cool as fast as it would if it did not have the threads cut on it. This being true, it must be controlled in some other way. It should be packed in a mixture of pulverized animal charcoal and crushed bone, the bone having been previously burned and the dust sifted out. It should be packed very carefully and surrounded by at least two inches of the mixture. It should not be heated in less than three hours, the furnace running at a heat that will heat it to the hardening temperature. Then take it from the fire and plunge into water, again cooling quickly. It sometimes happens that these plugs warp in the neck, but they can be easily be straightened.

I have used high-speed steel for thread gages with good results and with less work in lapping than is possible in using carbon steel. If high-speed steel is used, it should not be heated to as high a heat as would ordinarily be given this steel. The heat should not go above *1200 degrees Centigrade, bright orange,* being sure of course, not to get the plug in the air while heating or cooling, to the extent of scaling or blistering. It will be found that the change is very small on this class of steel. There are some certain classes of tools in which the expansion and contraction cannot be relied upon to go uniformly, but in cooling the gage ring and plug it will be found that the contraction and expansion are controlled largely by the rate of cooling. We find one man getting results of one nature and another of another; consequently most every point that I have urged can be disproved. In conclusion I will say, take it for what you find it is worth. Where a pyrometer is used, there is a possibility of getting the allowance exact for shrinkage or waste on high-speed steel heated in barium chloride.

Davenport, Ia. C. U. Scott.

Reducing the Thickness of Copper without Dies or Rolls

A "shop kink" which was new to the writer was stumbled upon by accident and developed into quite a simple method of overcoming a difficulty occasionally met with in our work.

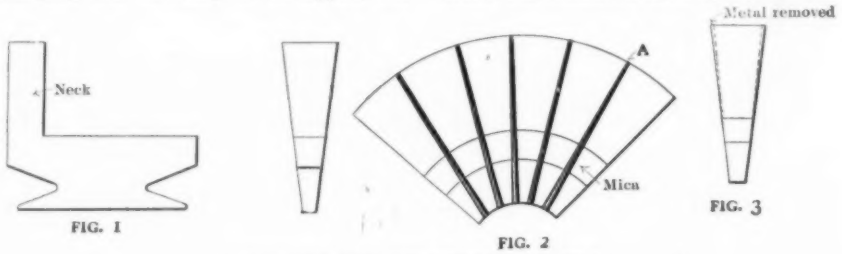


FIG. 1 FIG. 2 FIG. 3

REDUCING THE THICKNESS OF COPPER

We build many special commutators which require that the wedge-shaped cross-section commutator bars, Fig. 1, be ordered for that one commutator only, and it has happened in a few cases that the large end of the wedge has been too large by perhaps only two or three thousandths of an inch, but sufficiently over size to make the assembled commutator very tight at the outer and loose at the inner circumference; see Fig. 2. This has necessitated that this excess thickness of metal at the point *A* be taken off, the cut "running out" before it reaches the thin edge.

We have found it sufficient to let the cut "run out" before it reaches the body of the bar, Fig. 3. Our method is to dip the tail into ordinary soldering-salt solution and then immerse it in a pot of solder, thus "tinning" the tail. Upon removal from the solder bath the "tinning" is thoroughly rubbed off with a piece of cloth or waste, and it is found that a uniform thickness of copper has been removed.

The thickness of metal removed depends upon the length of time the copper is immersed in the solder. Thus we have a means of controlling the amount of copper removed and can produce the effect of a cut "running out" by keeping the very tip immersed, say three seconds, then immersing it a little deeper, and so on until the point is reached where the cut should "run out." The copper is held at this point only long enough to melt the "frozen" line of solder which forms upon a fresh portion of immersed copper. When the copper is removed and the tinning wiped off, it is found that the thickness of metal removed varies from zero at the least immersion to the greatest quantity at the point which was immersed the longest.

The rate at which metal can be removed depends upon the mass of copper to be heated and upon the temperature of the solder bath, and probably upon the composition of the bath. Ours is one part tin and two parts lead. A single trial was made to ascertain what the rate would be for our conditions. A crucible, containing about 10 pounds of solder and heated so that some parts of the crucible showed a bright red heat, removed metal from a copper strip 0.0625 inch thick by 1½ inch at the rate of about 0.006 inch per minute.

The proportion of the various metal elements before and after the operation has not been determined. One 10-pound bath has removed a comparatively large amount of copper and still continues to do so at the same rate. Perhaps the large amount of slag and scum found upon the top of the bath is copper. We have not investigated this.

At first thought this action seems quite contrary to that which one would expect; but when one remembers that babbitt alloys, etc., are prepared by melting the low-melting metals first and "dissolving" the high-melting ones at a low temperature, the explanation is simple. The surface of the copper simply alloys with the surrounding metals and the copper "dissolves."

Ampere, N. J. R. B. TREAT.

Odd Cause of Blow-holes

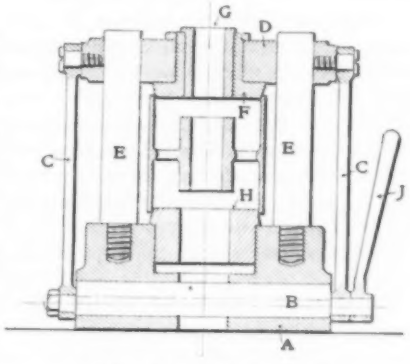
I have in my time read and heard a great many different reasons assigned for blow-holes in castings. I have had the misfortune to have charge of a foundry in my time, and I found that almost every molder had a different reason, the main object being to screen himself from blame. I had about come to the conclusion that the field for the ingenuity of the molder had been exhausted in the way of making excuses for blow-holes, but at page 547 I noticed an article by Dixie which I am sure will be welcomed by molders working in shops where heats are made once or twice a week. He says that the reason assigned for the loss of two heavy castings out of a lot of one hundred was due to a cause he had never seen advanced before. This, in my opinion, only goes to show that the molders of the present day are progressive and can invent new causes.

These two heavy castings that were lost were molded on Friday and cast on Monday. The cause assigned for the loss was some seeds (he doesn't say what kind) which got in the mold and sprouted. When the hot iron was poured on the sprouting seeds it caused blow-holes. The molder who invented this is certainly deserving of a medal. I am not much of an expert on the kind of seeds that germinate in two or three days, and as Dixie fails to throw any light on the subject, I think it would be in order for molders to guess. My guess is that it was a chestnut.

Cincinnati, Ohio. E. J. REX.

Jig for Boring Pulleys

Unless Mr. Reng is able to secure pulley castings superior to the usual foundry product, the jig he shows on page 560 would be very unsatisfactory in practice for the following reasons:



JIG FOR BORING PULLEYS

First, the pulley is trued up by the hub: in the ordinary pulley it is not essential whether the hub runs perfectly true or not.

Second, the pulley is not trued up by the inside of the rim. In the ordinary pulley, or any other similar piece for that matter, it is essential that the truing up be from the unfinished portion of the work if the cost of balancing and weight of balance pieces is to be a minimum.

Third, the pulley is trued up by one edge. In case of a swell on one edge, or loose flask pins causing a bad closing of the flask, it is pretty certain the pulley would be scrapped.

Fourth, too much time would be consumed in operating the clamping screw.

The jig shown is considered an improvement, although more costly to make. The cast-iron base *A* is bored for the shaft *B*, which carries on the eccentric ends the two connecting-rods *C C*, which impart a vertical motion to the yoke *D*, which slides upon the two turned and ground guide bars *E E* screwed into the base *A*. The yoke *D* carries a cone *F*, which in turn carries the hardened and ground bushing *G*, for guiding the drills and reamers.

The base *A* also carries a similar cone *H*. This cone is preferably screwed into the base to allow for a slight adjustment to compensate for possible variation in the width of the castings. The eccentric shaft *B* is revolved by means of the handle *J*, which need only swing through an angle of about 75 degrees.

The pulleys are centered by the inside of the rim at each edge, so that a shifting of flasks or swells makes but slight difference in the balancing required, as these pulleys are machine molded from iron patterns. The hubs are left rough and are not sufficiently eccentric to be objectionable.

Obviously the cones *F* and *H* must be adapted to each size of pulley bored, and the bushing *G* must also be adapted to the size of the drill or reamer used. In practice two jigs are used simultaneously, the pulleys being drilled in one and reamed in the other, effecting a saving in time in changing drills, reamers and bushings. One man operates both drill presses and can drill and ream pulleys in much less time than they could be finished in any turret lathe.

So many efficient pulley grinders are advertised that, after having seen the speed at which pulleys up to 36 or even 48 inches diameter may be ground, it seems curiously old fashioned even to think of turning them in the best of lathes with the most modern high-speed cutting tools.

Erie, Pa. W. GIBSON.

Collier's Ball Worm Gear

This device, as described by Mr. Booth at page 543, appears to be a very ingenious contrivance; but it seems to me that there is one point which has been overlooked in connection with Fig. 4, viz., no matter which worm is the driver, the worm wheel itself must always drive three different worms, and if two of these happen to be single-thread worms, I am afraid the task would be a close approach to the impossible.

Brooklyn, N. Y. WALTER GRIBBEN.

A Compound Gear Slide Rule—Erratum

At page 803, issue of November 21, the seventh line from the bottom of the first column under this heading should have read "Mr. Tilsey's cross-section is certainly no improvement over mine" instead of "an improvement."

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

During 1906 *the* AMERICAN MACHINIST *printed and circulated* 1,083,205 *copies, an average of* 20,832 *per issue. Of this issue* 36,500 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

Contents

PAGE

Interesting Operations in a Large Shop 853
New Arrangement of a Worm Gear Drive 858
An Old Patent on a Supposedly New Invention 859
Finding Change Gears by Prime-factor Tables 860
Premium Systems..... 861
Proper Care of Belts in the Shop..... 862
Laying Out Automatic Screw-machine Cams 866
Practical Letters From Our Readers: Self Adjusting Drill Jig....Metal Mold for Oiling Rings....Turning the Edges of Gong....Alleged Modification of Halsey's Premium Plan ....Measuring Dovetails....Wire-bending Fixture....Floating Reamer Holder....Elimination of Friction in Ball Bearings....Spring Forming Tool....Handy Micrometer and a Rubber Cutter....Proper Shop Training....Distortion of Steel in Hardening....Reducing the Thickness of Copper Without Dies or Rolls....Odd Cause of Blow Holes ....Jig for Boring Pulleys.... Collier's Ball Worm Gear.....871-879
A Suggestion on the Situation..... 880
Recent Machine Tool Developments in England 881
New Tools and Machine Shop Appliances 882-885

A Suggestion on the Situation

There are some financial troubles of one kind or another worrying the most of us.

Stop worrying.

All of this so called panic is caused by wrongdoing. None of it is caused by reason of "the conditions." In 1893 there were plenty of reasons for the panic—the crop failures alone being reason enough. Not one of these conditions obtains today.

The money trouble comes as the culmination of several disturbing factors.

First, the use of banked money for the reckless gambling of "high" finance, and the realization of the people that it was being so used.

Second, the exposures in the insurance investigations.

Third, the sudden conclusion of the common people that the banks were not safe.

Fourth, the attitude of the State governments toward the railroads.

Fifth, the propensity of our chief magistrate to tell what he was going to do to all corporations—not what he did.

All of these came to a head at once, producing a scare, and the bankers fell down—the worst scared of the lot. Currency was withdrawn from circulation and hidden—and the bankers hid most of it. Then there was the putting of currency on a fiat basis—clearing-house checks are no more money than beer checks or store orders.

There are thousands of reasons and opinions as to what brought it all about.

What difference does it make now?

What can we do to get back where we were? That is the question that confronts the business man and the manufacturer.

We have seen some circular letters from banks and trust companies asking for deposits and stating that the institutions in question had in their vaults much more currency than that required by law—this to give the prospective depositor confidence.

It is the one thing that ought to destroy his confidence in that bank.

The reserves are for just such emergencies. Accumulating beyond the requirements is the worst form of hoarding money.

Others hoard because they are ignorant, the banker should know.

It is time for concerted action among manufacturers and merchants in all towns of any considerable size.

It is time to point the finger of shame at the bankers who hoard now.

It is time to find out what banks are taking care of the great manufacturing interests, trying to keep them in funds to keep in operation—for there are some.

It is time to know what banks prefer to sell their currency for a premium or lend it to stock speculators for higher interest than they should ask of the producers, the constructive men, the men whose industries support the working people and are useful in the community.

It is time *you* started a movement in *your* town to help the situation locally.

Money is timid; all that hoarded by individuals in your city would come out for some form of safe investment if you and a dozen others, whom these people know and trust, would recommend some place to invest—even guaranteeing the investment.

A combination of securities could be offered, local institutions or railroad or industrial stocks and bonds already on the market.

See that such money finds its way back into circulation through some bank or banks that have an eye to their own welfare by using it to keep in motion the wheels of industry at home.

Stop talking panic. When such troubles come, brave men take to their work, cowards to the brush.

Strain every effort to keep your shop going—don't throw out of work the men whose suffering will make the times harder.

Don't hold up your bills if you can pay—it makes someone else do the same.

Don't countermand orders—it is catching. And don't accept countermands from solvent institutions where you have the materials bought and the work in hand.

Accept delayed delivery, longer time if need be, but no countermand. You have some rights in the matter, assert them.

The New York banks are doing better than most of them; there is less hoarding except in a few glaring examples. Many millions have been brought from Europe and the National treasury is trying to aid by the issue of short-time bonds.

There will more good come from the fact that the Government is willing to help than will come from the bonds themselves.

Hidden money earns nothing and is unsafe; coax it back into circulation. There is enough if it were available.

A thousand dollars turned loose Monday morning will have paid obligations of a hundred thousand before Saturday night and relieved many a firm's immediate necessities.

Let's stop trying to locate the cause.

Let's stop trying to devise a more elastic currency—Congress will do that.

Let's try as individuals to help the matter in our own little way in our own little field. You can influence someone with money to buy securities or put his money back in the bank. Do it.

You can make some banker realize that he will want to run a bank in your town after this so-called panic; induce him to do business now with this end in view.

The clouds are clearing; help push them away before things get so disorganized that an immediate return to the conditions of six months ago will be impossible.

There is a general movement all along

this line, headed by the Merchants' Association, the Credit Men's Association, the Trade Press Association and others.

Take off your coat and help—you are near shore, paddle a little; don't wait for the tide to take you out to sea. You are no floater.

Start the work today—call up some of your friends *now* and get busy.

Recent Machine-tool Developments in England

The illustrations and descriptions of machine tools at the recent Olympia exhibition in Great Britain which we find in our English exchanges give some excellent material from which to summarize the progress of machine-tool design in England, and they lead at once to the remark that if American machine-tool builders are to inaugurate another vigorous campaign for trade in Europe, they will find a different condition of things from that which prevailed there ten years ago. So far as can be judged from the exhibits at Olympia, English machine-tool builders have been quite as active during recent years as have our own. The clumsiness and unhandiness which formerly characterized British tools has, at least in these exhibits, largely disappeared. There is every indication that the British tool builder is now alive to the importance of handiness in operation and in one respect, at least, he seems to have gone further in this respect than have our American builders. In this we refer to the adoption of the all-gear headstock lathe with speed adjustments by clutches and levers. We are not prepared to say that the designs shown are any better, or, indeed, that they are as good as some of those made here, but it is, we think, true that a larger number of builders have radically modified the driving gearing of their lathes there than here. At this exhibition builder after builder showed lathes of this type in which the study of handiness was obviously paramount in the design, and in which, in so far as can be judged from illustrations, very little in that respect has been left undone.

In planer design the comparison is not so favorable to English builders, although it is obvious here also that they have not been asleep. Not so much appears to have been done with variable-speed planers as here, nor has the development of the clutch-driving system for planers of large dimensions gone so far. That the difficulty of putting sufficient power for modern requirements into large planers with the shifting belt has been recognized, is, however, manifest and devices which are unknown here have been brought out. It has long been a tradition that the superiority of American machine-tool design was most marked in planers, and we believe that this tradition still holds, but at the same time it is obvious that it will not do for American planer builders to rest on their laurels.

In the development of highly organized automatic machine tools, the English designer has also been busy, and in one respect, at least, he has led American builders, namely, in the development of the hobbing process for cutting spur gears, although in this, again, it appears that he was in turn led by German builders. American builders of gear-cutting machinery have only just awakened to the possibilities of the hobbing process, and this they have done after the example was set abroad, although the original conception of this method was, we believe, American. It is indeed strange, in view of the possibilities of that process, that it should have been allowed to lie unused so long.

In the development of special machines, English builders have also been active. There are now several English makes of screw milling machines, while special lathes for turning test pieces, special crank-shaft lathes and special grinding machines are common. In the development of tools for the utilization of high-speed steel, the massive character which has always been a feature of British tools has, of course, furnished an excellent foundation, and such tools have been pushed to a high degree of development. The turret lathe, or capstan lathe as it is called in England, has, of course, long been common there, although in simple form, and this, like other tools, has now been developed until machines of a high degree of elaboration and completeness are common—these like the engine lathe being frequently fitted with the all-gear headstock.

No one can examine the illustrations of the Olympia exhibits without being struck with the evidences of progress and with the fact that in them there was much to see and to learn.

New Publications

Die Dampfkessel. By F. Tetzner. Third, improved edition. 260 pages, 6x9⅛ inches; with 149 figures in the text and 38 lithographed plates. Julius Springer. Berlin. Price, 8 marks.

This is a very complete and copiously illustrated text-book on steam boilers, referring principally to boilers of the stationary type and of course to German practice. There is an illustration of a locomotive boiler, but the many varieties of this type are apparently not considered. Combustion, its theory and mathematics, are explained, and methods of calculation are given, both for the proportioning of complete boilers and the design of their various parts, as well as illustrations and descriptions of various designs, including a large variety of boilers with their furnaces, fronts, grates, valves and gages, economizers, superheaters, etc., as well as purification of feed water, boiler attendance (pretty brief), legal regulations, and the inspection and testing of boilers. There is no alphabetical index, but a much subdivided table of contents, there being sometimes as many as six successive subdivisions with corresponding symbols.

Die Schiffsschraube. By Albert Achenbach. Volume II. Its Construction, with an Appendix on the Screw Propeller Propulsion of Motor Boats. 152 pages 6⅛x9¼ inches; 20 plates and 18 tables. Robert Cordes, Kiel. Price, 14 marks.

This is the second of a set of three volumes on the screw propeller, the first of which we noticed at page 195, Vol. 29 (1906), Part 2. This part is essentially practical, treating of construction in detail, including the questions of materials, form, methods of fastening together, etc., working drawings, shop operations, measurements of the completed propeller, all pertaining especially to German naval and merchant practice. The Zeise and Niki propellers appear in this volume, as in the preceding. Considerable space is devoted to propellers for motor boats, including couplings, reverse gears and reversible or feathering propellers. Mechanically, the book is similar to the first volume; the illustrations are very good; it contains a short bibliography and a table of contents, but no alphabetical index. It would be well to have the latter included when the last volume makes its appearance.

Balancing of Engines, Steam, Gas and Petrol. By Archibald Sharp. 212 5½x8½-inch pages, with numerous illustrations. Longmans, Green & Co., London and New York. Price, $1.75.

The standard treatise on the balancing of engines is by Prof. W. A. Dalby, to which the author of the present volume acknowledges his indebtedness. The problem of balancing engines, especially those with more than one cylinder, is, of course, exceedingly complex and the present book differs from that of Professor Dalby chiefly in the increased use of graphical as against analytical methods. The result is a book of a high order of merit, and while the solutions cannot be called simple, they are probably as simple as the nature of the problems makes possible. The increasing use of engines mounted upon unstable foundations makes the problem of their balancing of growing importance, and to those who have to deal with the design and construction of such engines, Mr. Sharp's book can be cordially recommended. We wish we might see more technical books of the high character of this from American authors.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

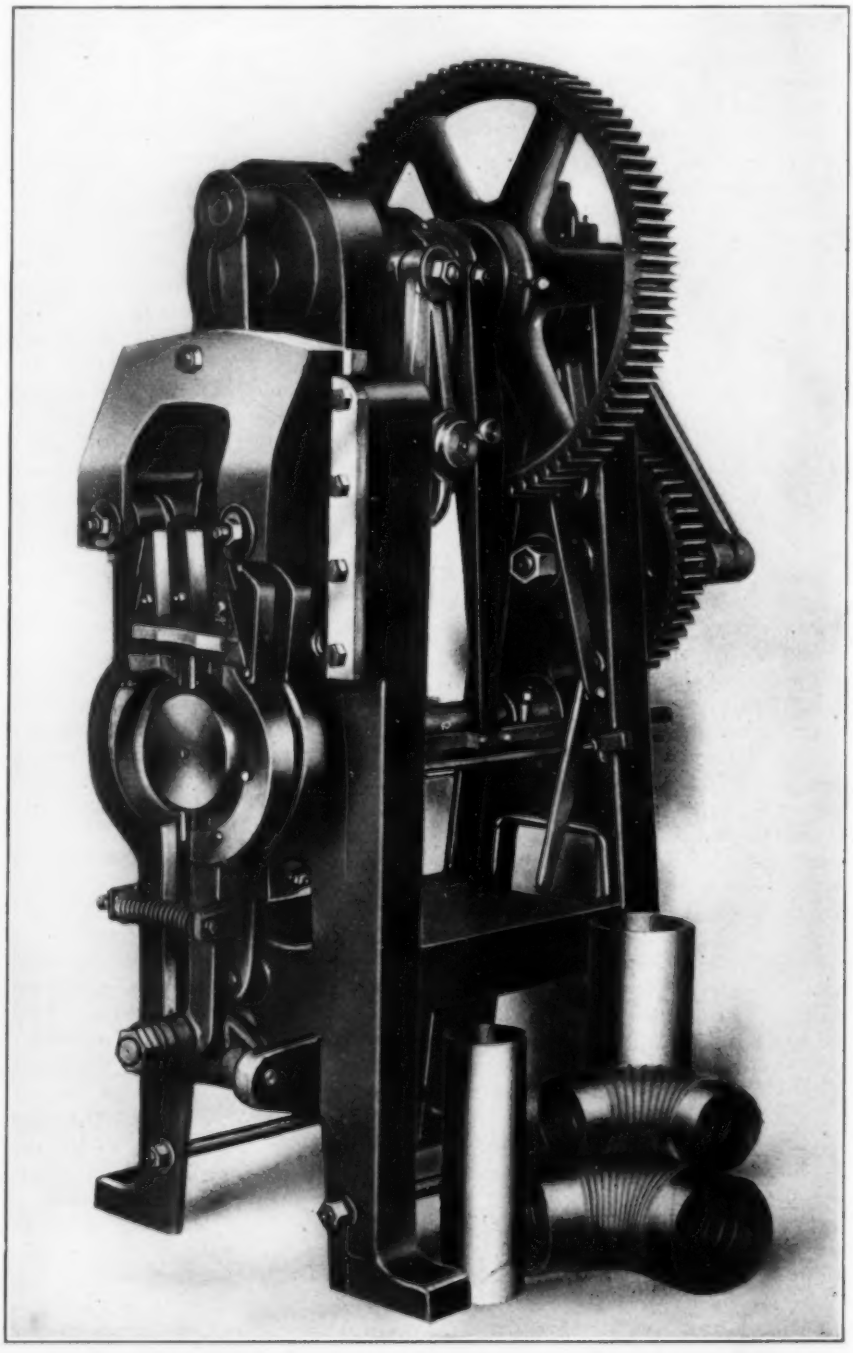
THE LATEST INFORMATION

A Machine for Making Elbows

We illustrate herewith a new pattern of a machine for making elbows. The machine is almost entirely automatic and is designed for making elbows from 4 to 7 inches, inclusive. It is fitted with an automatic clutch, and only has to be started by the operator, which is done by engaging the clutch by means of the hand lever shown; after the machine has traveled its required distance, it is stopped automatically.

For making the elbows, plain straight pipe or cylinders only are required. These cylinders are first prepared by rolling up plain straight sheets, having the two ends of the sheet lap about ½ inch. One end of the pipe can be riveted or the lap left loose, as desired. The plain cylinder is then slid over the round horn into the machine and into a chuck which also forms the shoulder or stop. This chuck is a plain simple expanded ring which is contracted by a small hand lever and screw for clamping onto the cylinder or pipe. The machine is then started by means of the hand lever engaging the clutch mechanism. The long, narrow, vertical lever passes down from the cam on the top shaft and engages with the horizontal bar, which also forms the rack feed, the pipe or cylinder being fed forward the required distance at each revolution of the machine by the cam-actuated movement on the upper shaft.

As the crank of the front end of the top shaft makes one revolution and the hood descends, the rolls in the hood engage with the two pairs of steel arms in front of the machine, which are fulcrumed at the lower end, and close these arms up tightly onto the cylinder, which has been previously fed forward on the horn over the expanders. As the machine continues to make its revolution, the expanders in the front portion of the horn are forced outward, expanding or forcing up on the one side of the elbow the required amount of metal. These expanders are operated by the gear on the back of the machine, which meshes in a pinion on the shaft running through the horn. After this operation the cam in the front of the rear cam on the top shaft, previously referred to, in which the rolls and device engage, forces or pulls back the front pair of arms or jaws in front of the machine; these fold up tightly that part of the metal of the pipe or cylinder which has previously been forced out by the expanders. These several operations, performed at one revolution of the machine by means of the automatic cam-actuated movements previously referred to, form one corrugation. The pipe is fed forward the 12, 13 or 14 spaces required for the corrugations; the elbow is then formed and completed in this manner, and automatically fed out of the machine, the machine stopping automatically at the completion of the last corrugation or rib. This work is perforated at the rate of about 60 to 75 ribs per minute, making it possible to form approximately 200 elbows per hour. The labor cost therefore in making elbows from the plain pipe is reduced to a minimum, as it is not neces-



MACHINE FOR CRIMPING AND BENDING ELBOWS

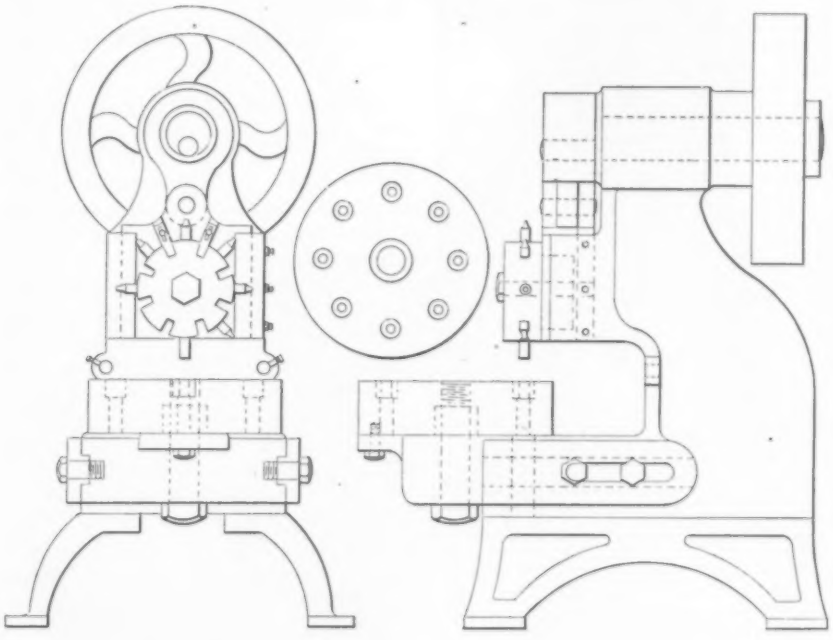
sary to clinch or close the seams prior to this operation.

This machine is designed and built by the Toledo Machine and Tool Company, of Toledo, Ohio.

A Turret Punch Press

The illustration shows a turret punch press designed for light work. The various sizes of punches are contained in a turret attached to the ram of the press, and the corresponding dies in another turret fastened to the bed. Each of these turrets can be rotated on a central stud and locked in correct position so that the punch and die will register. The lugs on the side of the housing are for attaching a suitable stripper.

This punch press is built by F. G. Marbach, Medina, Ohio.



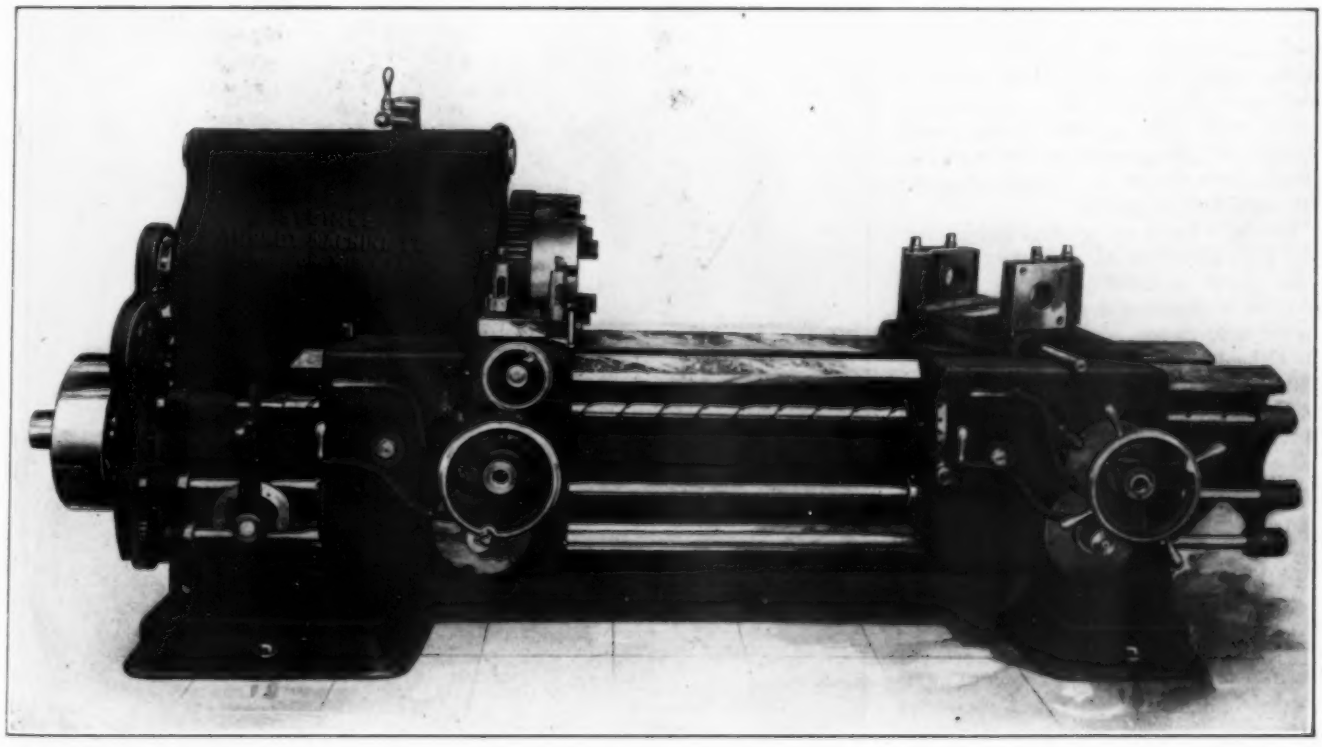
A TURRET PUNCH PRESS

A New Heavy Turret Lathe

To obtain the full benefits of turret-lathe methods in maintaining cast iron, forged parts, or steel castings, the two-carriage type of turret lathe, of which the new design shown herewith, due to the Steinle Turret Machine Company, of Madison, Wis., is an example, has been widely adopted. It derives its name, "the full-swing side-carriage turret lathe," from the novel construction of the tool-post carriage—a construction which gives greatly increased capacity with a nominal swing of lathe and, furthermore, allows the side carriage to be run past the front part of the chuck, out of the way of the turret, in which position it is shown in the accompanying half-tone. With the carriage in this position, the turret slide can be brought directly up to the chuck or work, thus overcoming the vibration of long overhanging tools.

The one-piece bed and housing, obviating the necessity of bolted parts, makes a solid construction to withstand the strain occasioned by the use of multiple broad shaving cutters fastened to the turret. The headstock design serves as a covering for the all-gear drive, which is placed underneath the spindle, thereby bringing the driving shaft as close to the base of the machine as possible.

The spindle motion is transmitted through a gear mechanism giving thirty changes of speed, arranged in three driving ratios of ten speeds each, in geo-



NEW HEAVY TURRET LATHE

metrical progression, with a gear ratio up to eighty to one.

Power is taken directly from the line shaft onto a constant belt speed pulley, with a friction control and a reversing motion which allows the headstock speed changes to be made under motion. All changes are controlled by interlocking levers, conveniently located, thus making disastrous results through carelessness of the operator impossible. When equipped with motor drive, any constant-speed motor can be used.

The two carriages rest on V's having a wearing surface of 2 inches in width on each face of the V, an equivalent of 8 inches of flat surface for the V's on which the turret slide rests. The distance between the V's is great enough to allow the chuck to hang well between them, in order to bring the center of gravity low and add to the stiffness of the structure.

The turret is hexagonal in form, four sides being finished with bored center holes and clamping surfaces for holding boring bars, etc., while the remaining two sides are open to receive universal facing heads for holding any form of facing and turning cutter. It is equipped with a rotating stop bar, with a dead stop for each face.

Both carriage and turret slides are equipped with rapid-power moving devices, controlled by convenient levers located on the carriage aprons.

Both carriages are screw cutting, arranged with eight feeds each, which are reversible and allow the carriages to be fed in like or opposite directions at differential speeds.

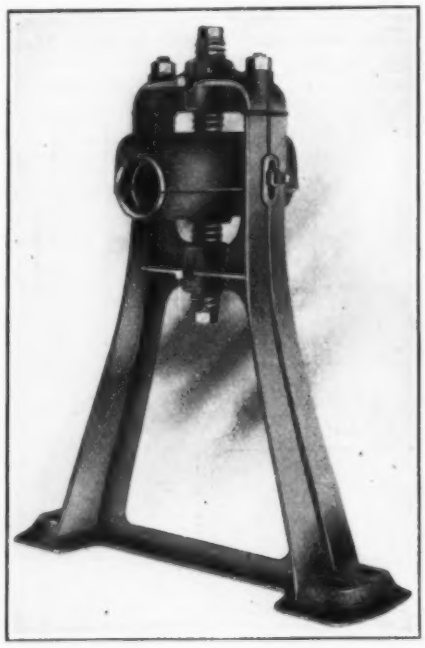
The tool-post carriage has power cross feed in the same ratio as the longitudinal feeds, and is fitted with a turret tool post with facilities for holding four standard tool-post tools or flat cutters. A standard set of tools, with universal facing heads suitable for the general run of work, or special tools for the more intricate work, are furnished as desired.

The lathe has a swing of 22 inches over the V's and 18 inches over the carriage. The spindle is bored 3½ inches and has a 5⅛-inch diameter front bearing. The turret is 20 inches in diameter across the flats, has 3-inch diameter holes for receiving tools and has a traverse of 52 inches from the face of the chuck. The driving pulley is 18 inches in diameter, takes a 5-inch belt and should run 360 revolutions per minute. The complete machine weighs 8000 pounds.

Ring-oiling Hanger

The aim in designing this hanger has been to secure such a distribution of metal as would give symmetry and maximum strength. They are universally adjustable, the threaded plungers which support the box having flat ends bearing on a spherical surface in the box, inside the raised edge which limits its movement. After the box has adjusted itself, the set screws at the side are run in to brace it against lateral stress.

The range of vertical adjustment is about one inch each side of the center, so that a 14-inch hanger can be used for anything between a 13- and 15-inch drop.



RING OILING HANGER

The bearings are of the ring-oiling type, tempered-steel rings being used in the regular way. The convenience of having hangers that will run a year between oilings is well worth considering in any shape.

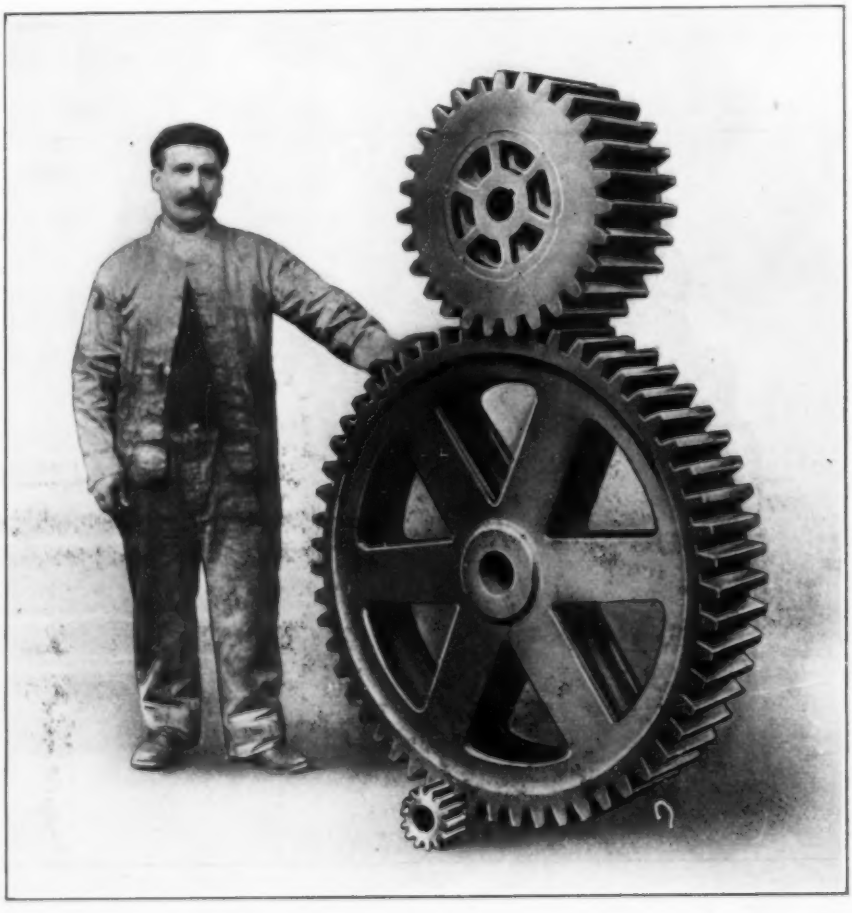
It is known as the Universal Giant hanger and is made for the Fairbanks Company, whose offices are in most large cities.

Paper Pinions

The accompanying illustration shows a new, noiseless, paper pinion which is the product of the British Insulated and Helsby Cables, Ltd., Prescot, Lancashire, Eng., and which is sold in this country by C. M. Dally, 29 Broadway, New York.

These pinions are made of the finest quality of manila paper, compressed in a 1000-ton press between brass, gun-metal or steel shrouds. It is claimed for them that they are not affected by changes in the temperature and that they do not absorb moisture or oil, things which are difficult to keep away from them when in practical use.

A special graphite lubricant, which increases the wearing qualities and gives a good hard surface to the teeth, is supplied by the company. The strength of the teeth



DIFFERENT SIZES AND STYLES OF PAPER PINI ONS

is said to be equal to that of cast iron, and they are much more elastic, while the weight is one pound for 23 cubic inches.

The paper pinion should be wide enough for the paper to have a full bearing on the teeth of the spur wheel and the flange or shroud run outside of it. The pinions are supplied cut ready for use, and also as blanks to be cut by the user.

New Self-oiling Loose Pulley

The Artisans Guild, of Benton Harbor, Mich., has designed and placed on the market a self-oiling loose pulley, as shown by Fig. 1. The claim is made that it overcomes the tendency of the oil to work out at the ends of the hub and throw it off of the shaft.

Around the hub is formed a large chamber, on the bottom of which rides a loose ring that barely clears the shaft at the top. This action taking place from the ring's own weight as the pulley revolves, picks up the oil from the bottom of the chamber and conveys it to the top of the shaft, on which it drips. Near the ends of the hub are provided annular grooves, from which ducts lead to the central chamber. As the oil works out to the ends of the hub, it is gathered up by the grooves and by the aid of the centrifugal force created by the motion of the pulley, passed through the ducts into the center chamber or reservoir. Thus a constant circulation of oil is provided and waste prevented.

The pulley with its loose ring is cast in one piece to avoid any unnecessary machine work or the possibility of joints leaking. The oiling mechanism is designed in such a manner that it may be constructed in the form of a bushing with a steel case, as shown by Fig. 2; this may have a wood or steel split pulley clamped about it, thus giving a self-oiling box.

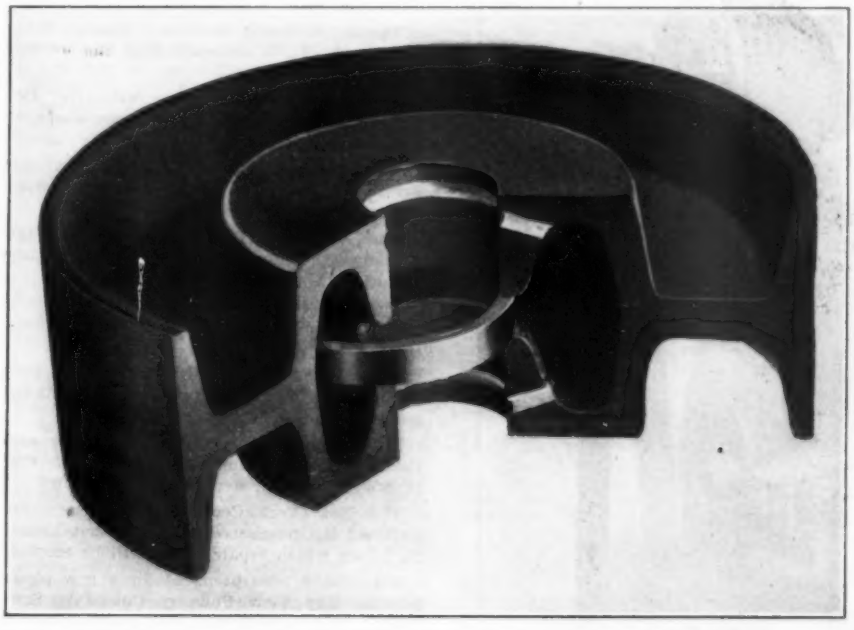


FIG. 1. SELF-OILING PULLEY

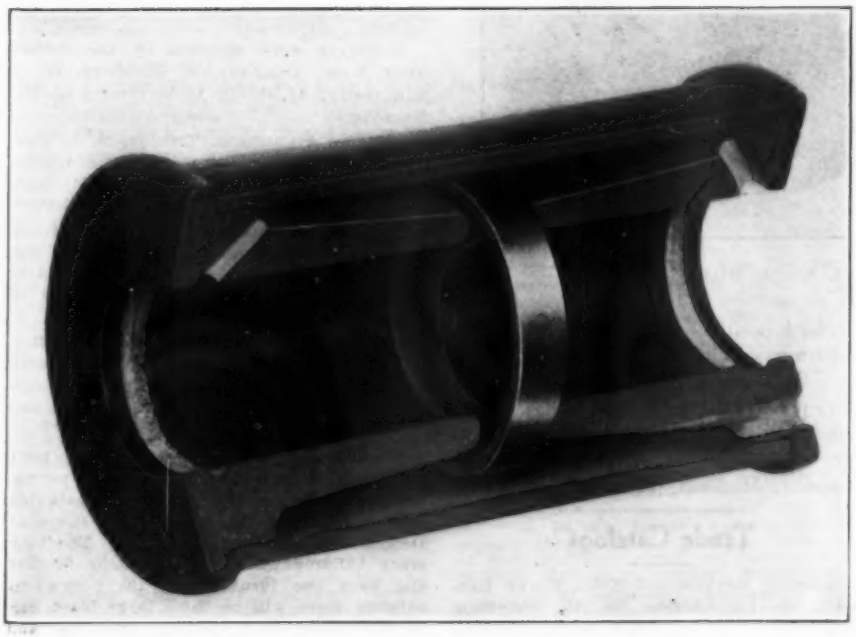


FIG. 2. SELF-OILING BUSHING FOR SPLIT WOOD OR IRON PULLEYS

A Core Oven

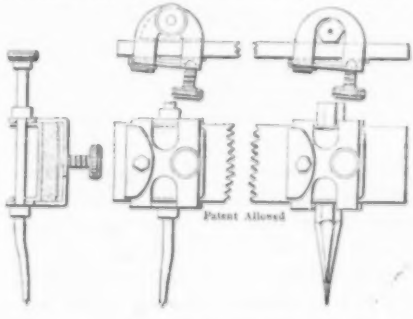
The illustration shows a portable oven for drying small cores. It was specially designed for the use of small foundries where it is not expedient to go to the expense of building a large oven. It has three shelves, two 4½ inches high and one

A CORE OVEN

9½ inches high, all of which are 23½ inches deep. The oven as shown is 44 inches high, 29½ inches wide and 32⅞ inches deep. It is called the "Cadet" and is made by the S. Obermayer Company, Cincinnati, Ohio.

A Beam Compass

The line cut shows a draftsman's beam compass made by Milton A. Smith, 91 Sabin street, Providence, Rhode Island. An ordinary pencil, drawing pen or other marking instrument can be clamped in one of the members. The pivot member provides for fine adjustment. Its spindle



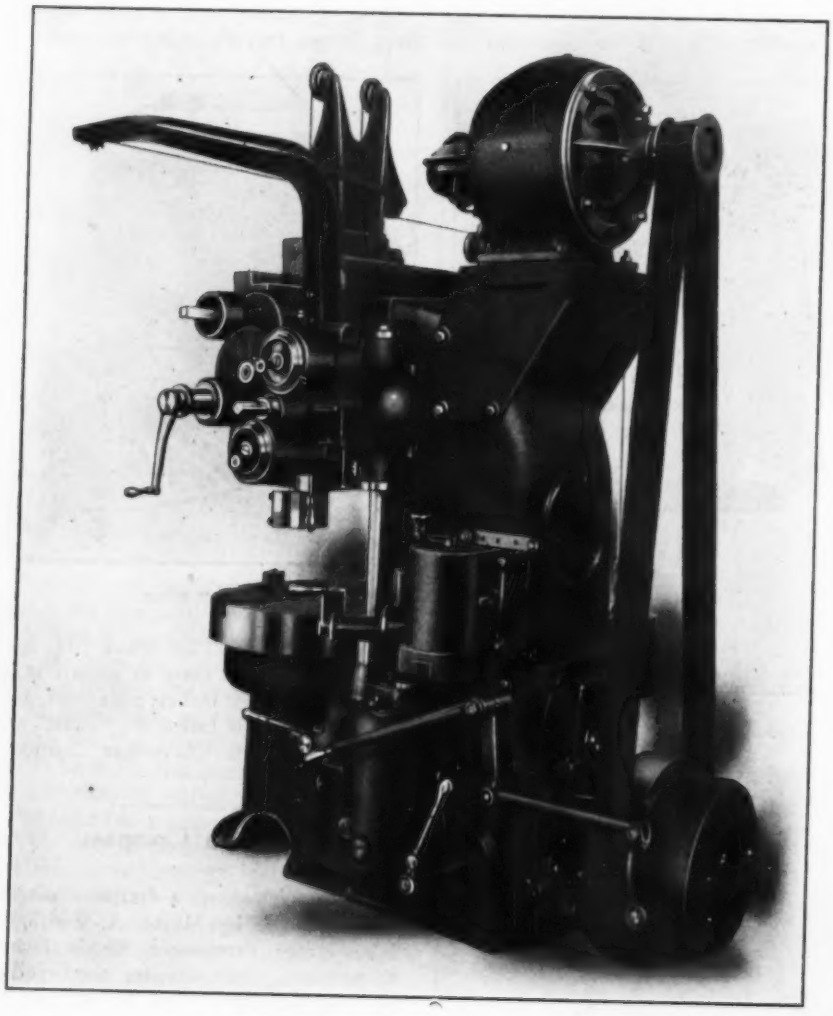
A BEAM COMPASS

is offset 1/16 inch; thus an adjustment of ⅛ inch is obtainable by rotating it in its bearings. The set-screw which holds the pivot-spindle slide in position on the beam is used to bring friction to bear upon the spindle and prevent its turning.

The instrument is made of steel, dull nickel plated. The beam is a rectangular stick 3/16x15/16.

A Motor-driven Vertical Boring Mill

The half-tone shows a motor-driven boring and turning mill. The motor is a



A MOTOR-DRIVEN VERTICAL BORING MILL

5-horse-power, variable-speed, 4 to 1 motor with speeds of from 400 to 1600 revolutions per minute. On this form of drive a single friction pulley controlled by a lever, as shown, is substituted for the three-step cone pulley used on the belt-driven machine. Through the friction device provided on the motor driven machine, the table is under the absolute control of the operator and may be started, stopped, or moved any fractional part of a revolution. Owing to the position of the motor as mounted, no additional floor space is required, the machine being self-contained.

The machine is provided with eight geared feeds and is equipped with a friction device reducing to a minimum the possibility of stripping gears through careless handling. The machine has micrometer index dials reading to 0.001 inch on all feed screws, by means of which the tool in the turret may be moved 0.001 inch or more in any direction without the use of a scale. By means of the feed-tripping device any feed may be positively or automatically stopped at any predetermined point; the dials for controlling the feed trip may be plainly seen at the end of the cross rail. This device will also trip any feed positively at either end of the feed traverse whether the dials are set or not. The machine may be fitted with either plain table or chuck, and has an extreme swing of 36½ inches.

It is made by the Gisholt Machine Company, Madison, Wisconsin.

Trade Catalogs

Lancaster Machine and Knife Works, Lancaster, N. Y. Catalog No. 16, describing ratchet braces, breast drills, machine knives, etc. Illustrated, 32 pages, 6x9 inches, paper.

Manufacturers

The Erie (Pa.) Pump and Engine Company will erect a new building.

The Milburn Wagon Company, Sutton, W. Va., will establish hub and spoke factory.

The Bucyrus Steel Company, Bucyrus, Ohio, will erect an addition to be 150 by 40 feet.

N. B. Hall & Sons, Decatur, Ala., whose basket factory was recently burned, will rebuild.

The Coffin Box and Lumber Company, St. Paul, Minn., will erect a new factory to cost $30,000.

The West Omaha Ice and Coal Company, Omaha, Neb., will construct a 25-ton ice-making plant.

The National Wood Pipe Company, of Los Angeles, Cal., will establish a factory at Portland, Ore.

The Topeka (Kans.) Box and Barrel Manufacturing Company will erect a two-story additional plant.

The W. A. Heath Machine Company, Binghamton, N. Y., is contemplating the erection of an addition.

The Grand Trunk Railway will erect two large additions to the Block I car shops at Port Huron, Mich.

The Minnesota Boiler Compound Company, St. Paul, Minn., will erect a new two-story factory building.

The Marshall (Texas) Car Wheel and Foundry Company will rebuild plant recently burned at a loss of $100,000.

Gust Lagerquist, Minneapolis, Minn., manufacturing hoisting machinery, has let contract for a new machine shop.

O. R. Biefeld & Co., Watertown, Wis., contemplate an addition to their steel foundry and machine shop to cost $20,000.

The tanneries of the American Hide and Leather Company and B. F. Kimball & Co., at Woburn, Mass., were destroyed by fire.

The New York Central & Hudson River Railroad has purchased a site in East Lyons, N. Y., on which repair shops will be erected.

Plans have been prepared for a new plant for the Bay View Foundry Company, Sandusky, Ohio, which will cost about $25,000.

The Grand Rapids (Mich.) Clock and Mantel Company, has awarded contract for the rebuilding of its plant recently destroyed by fire.

Contracts were awarded by the Schoen Steel Wheel Company, of Pittsburg, for a mill costing $1,500,000 to be erected at McKees Rocks.

Mallanee & Company, Trenton, N. J., manufacturers of steel type and type wheels, have incorporated as The J. D. Mallanee Company with a paid in capital of $10,000.

The Exeter Machine Works, Pittston, Penn., manufacturer of elevating and conveying machinery, etc., it is said, intends to build an addition for the manufacture of marine appliances.

The Maryland Metallic Bed Company, Baltimore, Md., has been incorporated with $25,000 capital to manufacture metallic beds. P. E. Graff, F. E. Graff, W. H. Rogers and others, incorporators.

Work on a temporary shop to be built prior to the erection of a larger and permanent structure for the purpose of installing a steel plant at the Wabash car shops at Decatur, will be started at once. The temorary building will be about 50 by 30 feet and have one furnace. In the permanent building there will be three large blast furnaces, rolling and welding machines and other apparatus necessary in the work.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free.E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Drafting done at reasonable rates. "J. W.," 10 Magnolia Ave., Jersey City, N. J.

Clockwork and clock-operated mechanisms. Larchmont Mfg. Co., Larchmont, N. Y.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Special machinery and manufacturing plants. Albert Pott, M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machinery, tools and fixtures designed; ideas developed, drawings made. Box 1264, Paterson, N. J.

Labor-saving appliances designed and installed. Geo. M. Mayer, 1461 Monadnock Blk., Chicago, Ill.

Special machinery designed and built; model and experimental work. A Wittemann, P. O. Box 693, Stapleton, S. I.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machinery Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Wanted—To interest capital in a trade school foundry; apprentice molders making commercial castings, by experienced foundryman and instructor. Box 651, AMER. MACH.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn.

You supply the machine, tool or other device, we create the demand and attend to the selling end of it. Sales managed and articles demonstrated. Specialty Sales Co., M. W. Haire, Mgr., 10 E. 42nd St., New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Our new up-to-date factory, well equipped for building light, medium or heavy machinery, desires to secure or contract for work; can guarantee all wood patterns that we manufacture; milling machine and pattern work a specialty. Steam Appliance Mfg. Co., Inc., Batavia, N. Y.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machines and punch parts, tools, jigs, etc.; we design and build special and experimental machinery, also automobiles and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

Machine Work Wanted—A New England foundry (with machine shop attached); A-1 reputation and thirty years' experience, desires to combine with a well established high-grade machine business, requiring castings; employing twelve to twenty men with competent manager; object being to reduce expenses and expand business for both parties; tide water shipping facilities, good business location; full investigation and references exchanged. For further information address Box 615, AMERICAN MACHINIST.

France; do you want to do business with France; I am contractor to the principal European Railway Companies, and have an important connection among the great constructors, engineers, mines, and automobile makers; I can introduce a suitable specialty; have you one? No antiquities required; would undertake agency of first-class high-speed machine tools for heavy cuts; only sound firms treated with; established 10 years in Paris; best references given and required. Address "Machinist," Care The Galignani Library, 224, Rue de Rivoli, Paris, France.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Assistant superintendent, 27; 5 years' experience shop work. W. E. C., 6405 Parnell Ave., Chicago.

MASSACHUSETTS

Tool and machine designer with large experience wishes to change. Box 655, AM. M.

Superintendent or chief draftsman; 16 years' experience steam and gas engines, boilers and general engineering; capable, reliable; 32 years old. Box 648, AM. MACH.

Electric welding specialist wants to change positions; superintendent of production and machine construction 5 years; experienced designer and draftsman on automatic machinery. Box 616, AMERICAN MACHINIST.

Position desired as New England representative for reliable house; Boston as headquarters; at present sales manager for manufacturing concern; high-class executive ability and business judgment; present salary, $2500; correspondence confidential. Box 664, AMERICAN MACHINIST.

NEW JERSEY

Draftsman, good at experimental machinery, also good at jig tools and fixtures; would like position. Box 658, AMER. MACH.

Technical graduate wants position as draftsman; experience on pumps and machine design; practical man. Box 657, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 661, AMERICAN MACHINIST.

Foundry foreman and manager is open for engagement; successful record. Box 650, AMERICAN MACHINIST.

Sales engineer; technical graduate; designer, general machinery; references. Box 669, AMERICAN MACHINIST.

Draftsman; first-class machine detailer and tracer desires position anywhere; best references. Box 666, AMERICAN MACHINIST.

Draftsman engineer, technical graduate; mechanical and structural designing; 9 years' experience; references. Box 670, AM. MACH.

Machine designer; technically educated, having 9 years' shop and drafting room experience desires position. Box 645, AM. M.

Draftsman, mechanical; 6 years' experience; technical graduate; desires position; references furnished, etc. Box 649, AM. M.

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Mechanical draftsman; 6 years of practical experience wants a position in New York, New Jersey or Connecticut. Box 662, AMERICAN MACHINIST.

Machinist, experienced drill press hand; married; 9 years in last position; sober, reliable; wishes permanent position out of New York. Box 653, AMERICAN MACHINIST.

Mechanical engineer; technical graduate; 28; experienced as designer, chief draftsman and superintendent on electric and special machinery manufacturing desires responsible position; A-1 references. Box 660, AM. M.

Superintendent; experienced in office, drafting room, pattern, foundry and machine shop; capable of successfully handling large force of men, reducing costs, and increasing production. Box 643, AMERICAN MACHINIST.

Mechanical engineer; 26; college graduate with technical and commercial experience, wants position as assistant superintendent; at present engaged; highest references; willing to go anywhere. Box 668, AM. MACH.

Superintendent or assistant by practical man with broad and varied experience; designing and building special tools system; organization, etc.; modern, energetic and inventive; all grades; deeds not words. Box 656, AMERICAN MACHINIST.

Competent designer automatic machinery, experienced in shop practice, desires responsible position, or offers services in own place equipped for small work, with apparatus for vacuum and electrical experiments in New York City. Box 665, AMERICAN MACHINIST.

Mechanical draftsman and designer; 26; college graduate with 6 years' practical experience on general work, special machinery, desires to change; at present engaged in New York; would go to South, Central America, or anywhere; A-1 references. Box 667, AMERICAN MACHINIST.

As superintendent or assistant by married man; age 32; expert mechanic, good executive; character and habits A-1; 15 years' experience on high-grade tools, etc., machinery, steam and gasolene engines; would like a change to grow up with a live concern. Box 654, AMERICAN MACHINIST.

OHIO

Mechanical draftsman, age 28, technical graduate with experience on tools, gas engine and automobile work wants position. Box 638, AMERICAN MACHINIST.

PENNSYLVANIA

Foreman toolmaker of fifteen men, now employed, but desires to make change; ten years' practical experience as toolmaker; thoroughly familiar with all classes of tool work for the rapid production of duplicate parts. Box 659, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted at once, a mechanical inspector for automobile parts; must be able to read blue prints and use micrometers. Apply to Box 652, AMERICAN MACHINIST.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

ILLINOIS

Wanted—Tool steel salesman; a permanent position is available to a first-class all around mechanic who can satisfactorily fill the bill as a tool steel salesman, capable of introducing high grade qualities; must have thorough acquaintance in Chicago, and the West. Address stating age, experience, and reference, "Tool Steel," 79 So. Jefferson St., Chicago.

MASSACHUSETTS

Help Wanted—A mechanic who has had experience in the manufacture of gages, both limit and thread, also in the handling of help. Box 634, AMERICAN MACHINIST.

MICHIGAN

Opportunity for ambitious machinists to become foremen; advertiser wants several such men to act now as inspectors of parts used in building automobiles, and to become foremen when fitness for such position is proved; open shop; small attractive town. Address Box 647, AMERICAN MACHINIST.

MISSOURI

Chief clerk, experienced in checking in and out going invoices doing some buying, and repair order man; salary $85 to $100 per month. Witte Iron Works Co., Kansas City, Mo.

Stock clerk, a competent inspector of work entering stock room, who can pass on its grade, properly take care of it, receive shipments, etc.; previous experience expected; salary $100 per month. Witte Iron Works Co., Kansas City, Mo.

Sales manager to look after the wants of, and obtaining agencies; an office man of large calibre, pleasing personality, fine correspondent, one who can obtain and hold large agencies; salary $1800 to $2400 per year, also interest in a highly profitable business after worth is demonstrated. Witte Iron Works Co., Kansas City, Mo.

Superintendent for works of 30,000 floor space to operate two hundred hands, want not less than two thousand engines per annum, 3 to 40 h.p. at lowest possible cost; factory equipment the very best and latest; must be an organizer of men and a systemizer of large experience; salary $1800 to $2400 per year, and interest in business also. Witte Iron Works Co., Kansas City, Mo.

NEW JERSEY

Wanted—First-class operators on B. & S. automatic screw machines; must be thorough-

ly experienced, and able to do close, accurate work. Box 663, AMERICAN MACHINIST.

NEW YORK

Designer, expert on all kinds of tool work, competent to take charge of designing and drafting department of 30 men. Write stating age, experience and salary expected to E. E. I., 41 West 34th Street.

Wanted—An experienced draftsman of both mechanical and structural architectural drawing for a technical school; permanent position for first-class man. Apply by letter stating qualifications and experience in full, to Instruction Committee, P. O. Box 37, Station D, New York.

Toolmaker; A-1 practical mechanic experienced in the manufacture of tools in all its branches and having experience in handling a large force of men; none but a man with such experience need reply; write stating age, experience and salary expected. "H. S. P.," 41 W. 34th St., New York.

OHIO

Wanted—Energetic, reliable man as foreman of up-to-date sheet steel department for range and stove work; good pay to right party. Write full particulars and references to "Fairman," Box 626, AMER. MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Streit pulley lathe 30" new; price $500. The Kern Machine Tool Co., Cincinnati, O.

Brass foundry; good paying business; excellent opportunity; price reasonable. Box 563, AMERICAN MACHINIST.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

Alphabetical Index to Advertisers

PAGE

Abrasive Material Co.....188
Acme Machinery Co.....112
Adams Co.....123
Adjustable Collet Co.....142
Albro Clem Elevator Co.....186
Almond Mfg. Co., T. R.....172
Alteneder & Son, Theo.....168
American Emery Wheel Wks.188
American Gas Furnace Co...124
American Pulley Co.....165
American School of Correspondence .....95 and 159
American Tool and Machine Co. 158
American Tool Wks. Co., 8 and 191
American Tube & Stamping Co. 197
American Watch Tool Co....122
American Wood Working Mchy. Co.....101
Ames & Co., B. C.....171
Andrew & Co., M. L..... 94
Armstrong-Blum Mfg. Co....171
Armstrong Bros. Tool Co....145
Athol Machine Co.....162
Automatic Machine Co.....131

Backus Water Motor Co.....166
Baker Bros.....134 and 161
Baker, S. S.....174
Baldwin Chain & Mfg. Co...171
Baldwin Steel Co..... 69
Bardons & Oliver.....106
Barnes Co., B. F.....121
Barnes Co., W. F. & John... 14
Barnett, G. & H..... 40
Bartlett, Edwin E.....141
Bath Grinder Co., Inc..... 34
Baush Machine Tool Co., 3d cover
Bay State Stamping Co.....166
Beaman & Smith....15 and 172
Beaudry & Co., Inc.....158
Becker-Brainard Milling Machine Co..... 23
Bemis & Call Hardware & Tool Co. 139
Bertsch & Co.....161
Besly & Co., Chas. H..... 94
Best & Co., L.....188
Bethlehem Foundry and Machine Co. 159
Bethlehem Steel Co.....153
Bickford Drill & Tool Co.... 10
Bignall & Keeler Mfg. Co....136
Bilgram, Hugo.....186
Billings & Spencer Co.....126
Binsse Machine Co..... 40
Birdsboro Steel Fdry. & Mach. Co. 106
Blaisdell Machinery Co..... 86
Blanchard Machine Co..... 85
Bliss Co., E. W..... 25
Blood Bros. Machine Co..... 94
Blount Co., J. G..... 32
Boston Gear Wks.....184
Bowsher Co., N. P.....171
Box & Co., Alfred.....164
Boynton & Plummer.....140
Bradford Machine Tool Co... 5
Bradley & Son, C. C.....138
Bridgeport Safety Emery Wheel Co. 189
Bristol Co. .....4th cover
Bristol, Wm. H..... 40
Brown Co., H. B.....171
Brown & Co., R. H.....173
Brown & Sharpe Mfg. Co., 63 and 4th cover
Brown Hoisting Mchry. Co..164
Brubaker & Bros., W. L.....170
Brunswick Refrigerating Co..159
Bullard Auto. Wrench Co....100
Bullard Mach. Tool Co..... 39
Burke Electric Co.....180
Burke Mchry. Co.....157

PAGE

Burr & Son, John T.....157
Burroughs Co., Chas.....157
Bury Compressor Co..... 86
Butterfield & Co.....114
Byram & Co., Inc.....170

C & C Electric Co.....178
Caldwell & Son Co., H. W....167
Cammell Laird & Co.....153
Carborundum Co..... 24
Card Mfg. Co., S. W..... 30
Carpenter Tap & Die Co., J. M. 134
Carr & Co., Stuart R.....156
Carver File Co..... 87
Case Mfg. Co.....164
Cell Drier Machine Co.....150
Chadwick & Trefethen.....170
Champion Tool Works.....183
Chicago Flexible Shaft Co...146
Chicago Pneumatic Tool Co.. 86
Chicago Raw Hide Mfg. Co..174
Cincinnati Elec. Tool Co....182
Cincinnati Lathe & Tool Co.. 82
Cincinnati Machine Tool Co..124
Cincinnati Milling Machine Co. .....6 and 7
Cincinnati Planer Co..... 33
Cincinnati Pulley Mchy. Co..169
Cincinnati Shaper Co.....195
Clark Cast Steel Cement Co.156
Clark, Jr., Elec. Co., Jas....181
Clark Auto. Telephone Switchboard Co. 116
Clayton Air Compressor Wks. 86
Cleveland Auto. Mach. Co., 26 and 27
Cleveland Cap Screw Co....158
Cleveland Crane & Car Co...164
Cleveland Planer Wks.....197
Cleveland Stone Co.....189
Cleveland Twist Drill Co., 4th cover
Cleveland Wire Spring Co..158
Cling-Surface Co.....160
Clough, R. M.....157
Coates Clipper Mfg. Co.....148
Coes Wrench Co.....20 and 21
Colburn Machine Tool Co....125
Cook Co., Asa S.....171
Consolidated Press & Tool Co.151
Crescent Forgings Co.....142
Crocker-Wheeler Co.....180
Crosby Steam Gage & Valve Co. 17
Cullman Wheel Co.....170
Curtis & Co. Mfg. Co.....164
Curtis & Curtis Co.....170
Cushman Chuck Co.....174

Davis Machine Co., W. P....191
Desmond-Stephan Mfg. Co...189
Detrick & Harvey Mach. Co..171
Diamond Chain & Mfr Co..136
Diamond Saw and Stamping Works 99
Dickinson, Thos. L.....188
Diehl Mfg. Co.....182
Dill Slotter People..... 17
Dixon Crucible Co., Jos.....141
Dreses Machine Tool Co.....132

Earle Gear & Mach. Co.....186
Eastern Machinery Co.....158
Eberhardt Bros. Mach. Co...186
Eck Dynamo & Motor Co....182
Economy Drawing Table Co.168
Electric Controller & Supply Co. 178
Elliott Chemical Works.....170
Elmes Engineering Works, Chas. F.....150
Emmert Mfg. Co.....163
Erie Foundry Co.....149
Errington, F. A.....173
Estep & Dolan.....171
Evans Friction Cone Co..... 85
Excelsior Needle Co.....133

PAGE

Farrel Fdry. & Machine Co..152
Fawcus Machine Co.....186
Fay Machine Tool Co..... 1
Fellows Gear Shaper Co..... 79
Felton, Sibley & Co.....158
Ferracute Machine Co..... 89
Firth-Sterling Steel Co.....155
Fitchburg Machine Wks..... 31
Flather Planer Co., Mark....114
Foote Bros. Gear & Mach. Co.186
Foote-Burt Co., The.....120
Fosdick Machine Tool Co.... 16
Franklin Mfg. Co., H. H.....119
Franklin Port. Crane & Hoist Co. 165

Gang Co., Wm. E.....171
Garden City Fan Co.....156
Gardner Machine Co.....188
Garvin Machine Co..... 84
Gem Mfg. Co.....166
General Electric Co.....176
General Pneumatic Tool Co..165
Geometric Tool Co..... 9
Gisholt Machine Co.....198
Gleason Works.....4th cover
Globe Machine & Stamping Co.156
Goldschmidt Thermit Co.....154
Goodell-Pratt Co..... 96
Gorton Machine Co., Geo....111
Gould & Eberhardt.....186
Graham Mfg. Co.....163
Grant Gear Wks.....184
Grant Mfg. and Machine Co.117
Gray Co., G. A..... 18
Gray & Prior Machine Co., 85 and 161
Greaves, Klusman & Co.....159
Greenfield Machine Co.....108
Gronkvist Drill Chuck Co., 135 and 172

Hammacher, Schlemmer Co.. 75
Hanna Engineering Wks..... 82
Hardinge Bros.....146
Harrison & Knight Mfg. Co..139
Harrington, Son & Co., Edw.121
Hart & Cooley Co.....137
Hart Mfg. Co.....157
Heald Machine Co..... 88
Hebert Sales Co.....161
Hendey Machine Co..... 71
Henley Pub. Co., Norman W. 73
Henry & Wright Mfg. Co.... 89
Herfurth Co., R. W.....191
High Duty Saw & Tool Co...133
Hill, Clarke & Co., Inc. 34 and 193
Hill Publishing Co...40, 83, 194
Hisey-Wolf Machine Co.....115
Hoefer Mfg. Co.....138
Hoggson & Pettis Mfg. Co...172
Horsburgh & Scott Co.....187
Horton & Son Co., E.....172
Howson & Howson.....170
Hunt Co., Robt. W.....170
Hurlbut-Rogers Machine Co..119

Ideal Opening Die Co.....190
Industrial Oxygen Co.....153
Ingersoll Milling Machine Co.130
Ingersoll-Rand Co..... 87
International Correspondence Schools 107

Jackson, Henry Docker.....174
Jacobs Mfg. Co.....175
Jantz & Leist Elec. Co.....180
Jenkins Bros. 167
Johnson Machine Co., Carlyle 102
Jones & Lamson Mach. Co., 12, 13 and 40
Juengst & Sons, George.....169

Kearney & Trecker.....103
Kelly Co., R. A.....161
Kempsmith Mfg. Co..... 22
Kern Machine Tool Co.....175
Keuffel & Esser Co.....168

PAGE

Keystone Steel Casting Co...154
Knight Machinery Co., W. B.156
Kolesch & Co.....168
Krupp (Thos. Prosser & Son).154

L. & D. Co.....171
Landis Machine Co.....182
Landis Tool Co..... 65
Lang Co., G. R..... 85
Lapointe Machine Tool Co....147
Lea Equipment Co.....183
LeBlond Machine Tool Co., R. K....142, 149 and 4th cover
LeCount, Wm. G.....174
Leonard Mfg. Co.....170
Link Belt Co.....110
Lodge & Shipley Machine Tool Co. 4
Long & Allstatter Co.....140
Lucas Machine Tool Co.....196
Lufkin Rule Co.....168
Lumen Bearing Co.....153
Lunkenheimer Co.....167
Lyon Metallic Mfg. Co.....163

Macdonald & Macdonald.....170
Manning, Maxwell & Moore, Inc. .....92 and 93
Manufacturers Fdry. Co.....153
Manufacturers Equipment and Engineering Co. 86
Manville Bros. Co.....109
Maris Bros. 164
Marshall & Huschart Mch. Co. .....191 and 193
Marston & Co., J. M.....170
Mass. Saw Works..... 98
Matthews, Hugh.....160
McCabe, J. J.....88 and 192
McDowell, Stocker & Co.... 87
Mechanics Machine Co.....160
Merrell Mfg. Co.....160
Merritt, Jos.....137
Merritt & Co. 85
Metal Hardening Solution Co.156
Millers Falls Co.....182
Milton Mfg. Co..... 69
Miner & Peck Mfg. Co.....159
Mittineague Paper Co.....167
Moline Tool Co.....161
Monarch Emery & Cor. Wheel Co. 188
Moore Co., Franklin.....165
Morris Foundry Co., John B.113
Morse Chain Co.....109
Morse Twist Drill & Mach. Co. 67
Morse, Williams & Co.....186
Morton Mfg. Co.....118
Morton & Co., B. K.....153
Mossberg Wrench Co.....157
Motch & Merryweather Machine Co. 192
Mueller Mach. Tool Co.....137
Mumford Co., E. H.....141
Mummert, Wolf & Dixon Co.136
Mutual Machine Co.....170

Nash Co., Geo. 94
National Acme Mfg. Co.....198
National Machine Co.....160
National Machinery Co..... 99
National Machine and Tool Co. 167
New Britain Mach. Co.....137
New Haven Mfg. Co.....116
New Process Raw Hide Co....185
Newton Machine Tool Wks.. 11
Nicholls, William S.....165
Nicholson File Co..... 17
Nicholson & Co., W. H.....115
Niles-Bement-Pond Co., 2, 3, 35, 38 and 192
Northern Elec. Mfg. Co.....177
Northern Engineering Works.164
Norton Co. 81
Norton Grinding Co..... 80
Nuttall Co., R. D.....184

Obermayer Co., S.....153
Oesterlein Machine Co.....141

PAGE

O. K. Tool Holder Co.....159
Owen Mach. Tool Co..... 22

Parker, C. L.....170
Parker Company, Chas.....162
Patterson, Gottfried & Hunter, Ltd. 186
Pawling & Harnischfeger....164
Paxson Co., J. W.....156
Philadelphia Bourse.....139
Philadelphia Gear Works....184
Piers, Frank.....158
Pike Mfg. Co..... 75
Pittsburg Auto. Vise & Tool Co. 162
Plunket, J. E..... 85
Poole Co., J. Morton.....120
Potter & Johnston Mach. Co. 71
Powell Co., William.....167
Pratt Chuck Co.....174
Pratt & Whitney Co...36 and 37
Prentice Bros. C..... 29
Prentiss Tool & Supply Co., 123 and 192
Prentiss Vise Co.....163
Prosser & Son, Thos.....154

Queen City Machine Tool Co.112

Ransom Mfg. Co.....188
Reece Co., E. F.....156
Reed Co., F. E.....144
Reed Co., Francis.....161
Reed Mfg. Co.....163
Reichheim Co., E. P.....160
Remington Tool Mach. Co.... 85
Rhoads & Son, J. E.....105
Ridgway Dynamo & Engine Co. 180
Risdon Tool Works.....171
Rivett-Dock Co.....3d cover

PAGE

Rivett Lathe Mfg. Co....3d cover
Robertson Mfg. Co.....150
Rock Island Tool Co.....162
Rockwood Mfg. Co.....164
Rogers & Hubbard Co.....156
Rogers Wks., John M.....134
Roth Bros. & Co.....180
Rowell Co., W. G.....153
Royersford Fdry. & Mach. Co.158

Safety Emery Wheel Co.....188
Sames, C. M.....183
Saunders Sons, D.....160
Sawyer Gear Wks.....184
Sawyer Tool Mfg. Co.....170
Schieren & Co., Chas. A.....143
Schmitz, August.....161
Schumacher & Boye..... 9
Schwerdtle Stamp Co.....171
Seaver, John W.....160
Sebastian Lathe Co.....138
Sellers & Co., Inc., Wm..... 28
Seneca Falls Mfg. Co.....118
Shelby Steel Tube Co.....154
Shultz Belting Co.....107
Sibley Mch. Tool Co.....151
Skinner Chuck Co.....172
Slate Machine Co., Dwight..117
Slocomb Co., J. T.....104
Sloan & Chace Mfg. Co.90 and 91
Smith Countershaft Co..... 31
Smith, M. A.....168
Smith & Mills.....171
Smith & Post Co.....131
Smith Co., Wm. J.....125
Spacke Mach. Co., F. W..... 87
Specialty Sales Co.....191
Sprague Electric Co.....179
Springfield Mach. Tool Co... 15
Standard Connecting Rod Co.166

PAGE

Standard Engineering Works.163
Standard Gauge Steel Co....135
Standard Roller Bearing Co..157
Standard Tool Co.....127
Standard Welding Co.....110
Stanley Works.....191
Stark Tool Co.....157
Starrett Co., L. S..... 97
Stevens, Frederic B.....154
Stoever Foundry & Mfg. Co..183
Stow Mfg. Co.....182
Struthers-Wells Co.....166
Sturtevant Co., B. F..... 32
Swaine Mfg. Co., Fred J.....135

Tabor Mfg. Co.....139
Taylor & Fenn Co.....113
Taylor-Wilson Mfg. Co.....187
Technical Supply Co.....168
Tindel-Morris Co.....198
Toledo Machine and Tool Co.140
Toomey, Frank.....191
Triumph Electric Co.....148
Tudor Mfg. Co.....129
Turner Brass Wks.....170
Turner Machine Co.....163

Underwood & Co., H. B.....138
Union Mfg. Co.....174
Union Twist Drill Co..... 77
United Engineering & Foundry Co. 88
Universal Draft. Mach. Co..169
Universal Machine Screw Co.190
U. S. Electrical Tool Co.....182

Van Dorn & Dutton.....184
Vandyck Churchill Co.....135
Veeder Mfg. Co.....168
Vitrified Wheel Co.....189
Von Wyck Mach. Tool Co....122

PAGE

Wagner Elec. Mfg. Co.....180
Walcott & Wood Mach. Tool Co. 132
Walker, N. U.....165
Wallace Supply Co.....171
Waltham Machine Works....171
Waltham Watch Tool Co.... 89
Ward & Sons, Edgar T.....152
Warner & Swasey Co.....196
Warner Instrument Co.....159
Waterbury Farrel Fdry. & Mach. Co.....134
Waterbury Gear Co.....186
Watson-Stillman Co.....130
Wellman Co. 171
Wells Bros. Co.....149
Wells & Son, F. E.....128
Western Electric Co.....177
Western Tool Mfg. Co.....150
West Haven Mfg. Co.....136
Westinghouse Elec. & Mfg. Co.177
Westmacott Gas Furnace Co..170
Weston Elec. Instrument Co.180
Whitcomb-Blaisdell Mach. Tool Co. 19
Whitman & Barnes Mfg. Co..147
Whitney Mfg. Co..... 61
Whiton Machine Co., D. E...173
Wiley & Russell Mfg. Co....111
Williams & Co., J. H.....159
Williamson Vise Co.....163
Wilmarth & Morman Co.....190
Winkley Co.....166
Wood's Sons Co., T. B.....108
Woodward & Powell Planer Co. 148
Worcester Machine Screw Co.182
Wormer Machinery Co., C. C.193
Wrigley Co., Thos.....189
Wyke & Co., J.....168

Classified Index to Articles Advertised

Abrasive Materials

Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Best & Co., L., New York.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Walker, N. U., Boston, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toledo Machine and Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bertsch & Co., Cambridge City, Ind.
Bethlehem Foundry and Machine Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Swaine Mfg. Co., Fred J., St. Louis, Mo.

Bending Tools, Hand

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Garden City Fan Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Keuffel & Esser Co., New York.

Blue Print Paper

Keuffel & Esser Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Phila., Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine and Tool Co., Toledo, Ohio.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Carr & Co., Stuart R., Baltimore, Md.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Fdry. Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Krupp (Thos. Prosser & Son), New York.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
National Machine Co., Hartford, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.

Chains, Driving—*Continued.*

Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Reed Co., Francis, Worcester, Mass.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Core

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Cell Drier Machine Co., Taunton, Mass.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

The Microscope in the Tool Room*

How a Great Variety of Operations in Connection with Tool Work May Be Facilitated by the Use of the Microscope

BY F. A. STANLEY

Of the many tools and appliances adapted to facilitate the production of accurate work in the tool room, one instrument at least has been sadly neglected. This is the microscope, which although commonly regarded as a scientific instrument whose field of usefulness is confined to the laboratory, has, nevertheless, a great number of applications in connection with tool work. It will be understood that reference is made here not to the ordinary magnifying glass, but to the compound microscope with cross hairs in the eye piece, an instrument whose adaptability to the purposes of the toolmaker will be outlined in this article, in connection with the accompanying halftones and line engravings.

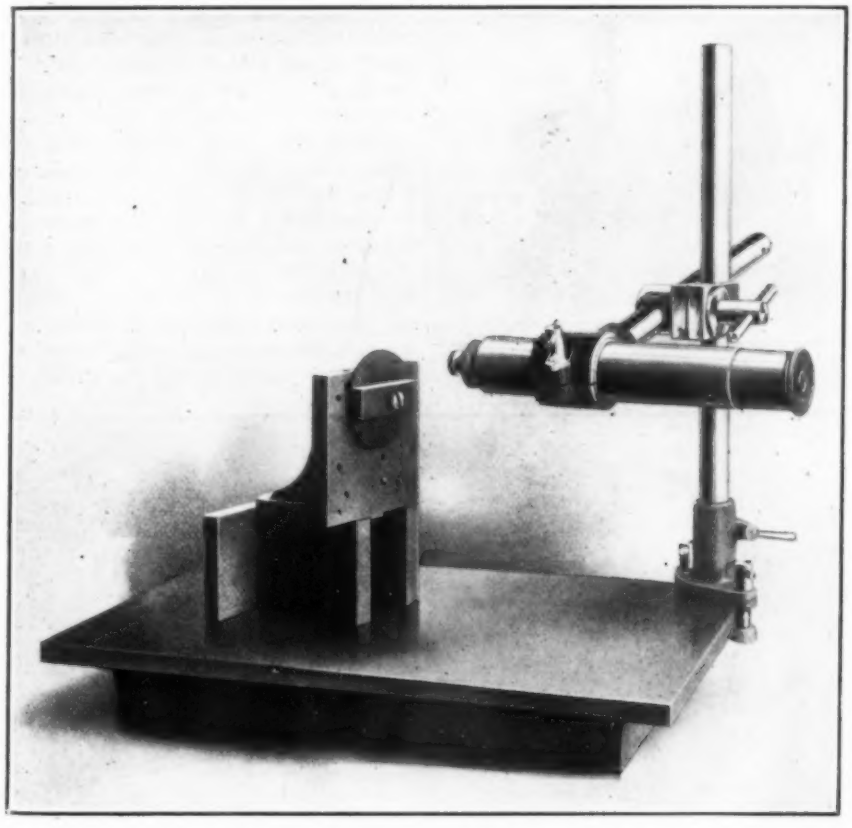


FIG. 1. THE MICROSCOPE ON THE SURFACE PLATE

Several years ago Walter Gribben described in the columns of the AMERICAN MACHINIST a method of measuring a steel tape and a scheme for centering work on the lathe face plate, using the microscope in both cases for setting the work accurately. A few others have since then adopted this device for use on some classes of work; so far as is known, however, not over three or four machine shops at the most have made any extensive use of this convenient instrument on general tool work. One of the believers in and users of the microscope for many operations is W. A. Warman, of the Keller Mechanical Engraving Company, of this city, Mr. Warman, like Mr. Gribben, being a contributor to these columns, needing no introduction to AMERICAN MACHINIST readers.

Mr. Gribben's instrument is shown mounted on a surface plate in Fig. 1, and attached to the slide rest of a bench lathe in Fig. 2. Fig. 3 illustrates a form of microscope used by Mr. Warman and manufactured by the Keller company, this instrument being mounted in a very similar fashion to a regular surface gage. In the cases of both instruments shown, the working distance is about 1.4 inches and the magnifying power about 25 diameters. The cross hairs intersect at an angle of 30 degrees, as indicated in the numerous sketches reproduced herewith.

LOCATING WORK ON THE FACE PLATE

One of the most convenient uses to which the microscope can be put is in locating a job, say a jig plate, by a pair of lines scribed on the surface, there being no necessity in this case of center punching the point of intersection and using this as a center by which to indicate the plate. In Fig. 4 let diagram *A* indicate the field of view of the microscope, showing the cross hairs, while *B* shows in the field two lines (of course greatly magnified) crossing at a point where it is desired to bore a hole in the plate. Prior to attempting to center the work, the microscope itself is centered by focusing it upon some point on the plate which appears to be stationary while the lathe is running, and also rotating the microscope tube itself in its clamping sleeve until one of the cross hairs is approximately horizontal. With the microscope shown in Fig. 2, any slight vertical adjustment necessary is easily obtained, owing to the instrument being held by friction in the clamp which is attached to the slide rest of the lathe. Thus the tube may be tilted slightly up or down and will remain stationary wherever set. It will be understood, of course, that a slight inclination in the axis of the microscope does not in any way affect the correctness of the results obtained.

Now assuming that we have the cross hairs approximately central with the axis of the lathe spindle, the lines on the work, appearing as at *B*, Fig. 4, the next operation is to shift the work to bring the horizontal line approximately central with the horizontal cross hair as shown at *C*. While this move apparently means lifting the work slightly on the plate, actually it means moving it downward, as the compound microscope reverses all images in the field. It is, therefore, easier to start out on the centering operation with the work in reality just slightly above center, allowing it to be shifted downward across the plate. After moving the work until the horizontal line appears to be somewhere near central with the horizontal cross hair of the microscope, as shown at *C*, the microscope itself is moved until the horizontal hair is just on the edge of the work line, as at *D*. The amount which the instrument is shifted is indicated (greatly magnified) at *a*. Next, the face plate is turned half over, and then, assuming that the lines scribed on the plate appear as at *E*, the amount which the work is apparently out of center is indicated doubled by the gap *b*.

*Copyrighted, 1907, by Hill Publishing Company.

Now the instrument is shifted slightly, or until the horizontal cross hair has apparently split the previous error, shown at *c*, its position then being as indicated at *F*, and the work is shifted to bring the edge of the line again coincident with the cross hair, as at *G*. The face plate and work are again turned halfway over, and if the setting is correct, the other side of the line will coincide with the cross hair, as shown at *H*. If there is still an error in the setting, the microscope is again shifted to take up half this error and the work shifted the other half. The object, of course, in turning the face plate halfway round is to bring opposite sides of the line in turn against the microscope cross hair, thus demonstrating that both edges of the work line are equidistant from the center line of the lathe spindle. The work, now being central in one direction, is adjusted until the other line has been centered with the cross hair; a final sight may then be taken on the line first centered to determine if readjustment by this line is necessary.

While the foregoing paragraph and the sketches in Fig. 4 show the method of centering one line first and repeating the series of operations for the other line, actually the work may be expedited by approximately centering each work line before attempting to center either accurately by the edges, as shown at *D*, *E*, *F*, *G* and *H*. While this method may appear to be somewhat lengthy, it is in fact a very quick way of centering a job. Its one great advantage is that the indicating point, that is, the intersection of the cross hairs, by which the work is centered, is really out in the air; that is, there is no mechanism to be brought into contact with the face of the work. Therefore the scribed lines are sufficient for centering purposes, thus doing away with the necessity for putting a center-punch mark at the point of intersection, which invariably means an error, greater or less according to the skill of the man who handles the punch.

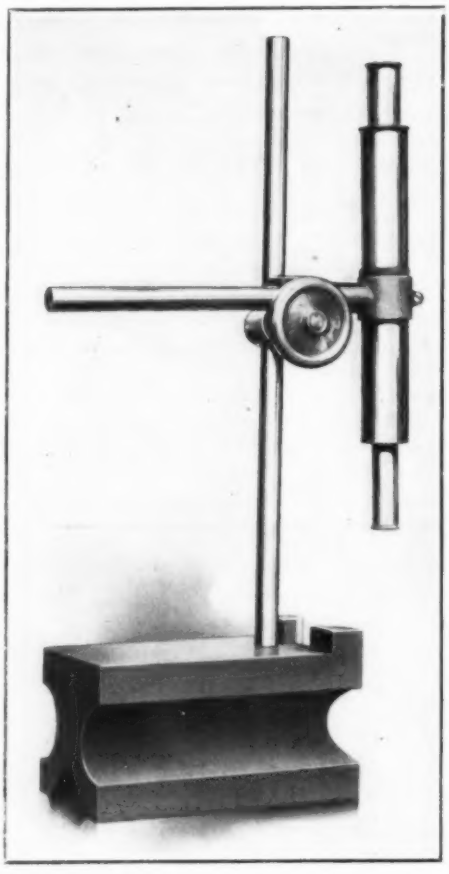


FIG. 3. A HANDY MICROSCOPE

Where care is taken to scribe lines on the work so fine that they are invisible to the naked eye, or nearly so, the work may be centered directly by adjusting until the lines show central with the cross hairs in the instrument, thus avoiding testing first one edge of a line and then the other. With carefully scribed lines the error in centering this way is exceedingly minute.

Sometimes in boring a hole in a piece held on the face plate, there is a possibility of the work shifting, during the roughing-out process. As a means of guarding against this, a circle is sometimes scribed from the center-punch mark; as the hole is enlarged, this circle can be watched and any movement of the plate will, of course, be shown by the travel of this circle. When boring out a piece with the aid of the microscope for setting, the test circle may be scribed by means of a scribing block placed on the lathe rest, making a fine line, as indicated in Fig. 5. After roughing out the hole, the microscope may then be set with one cross hair tangent to the circle, and any out of center movement which the work may make during the boring of

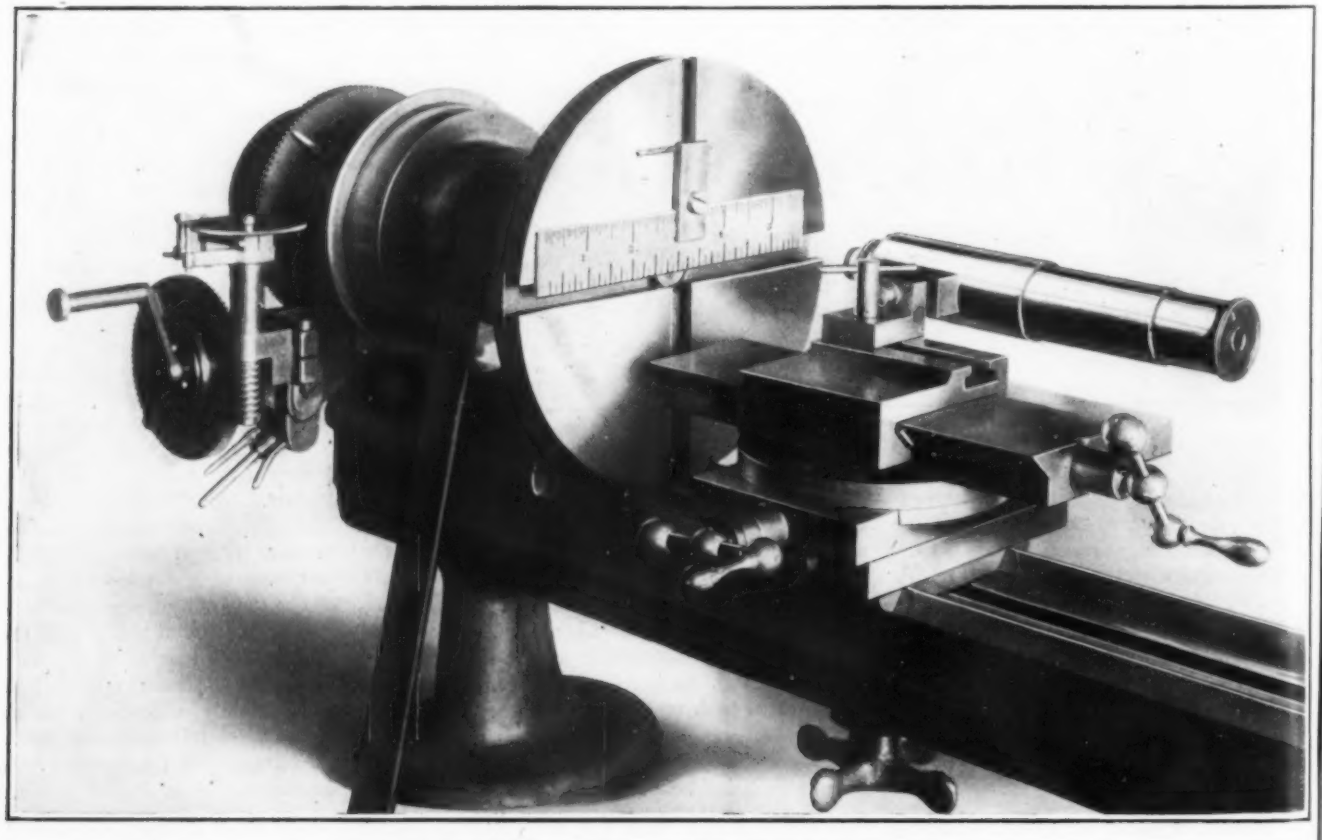


FIG. 2. THE MICROSCOPE ON THE BENCH LATHE

the hole will be readily detected by watching the travel of the circle past the vertical hair, and the work can be shifted until no apparent to and fro movement of this circle takes place in reference to the cross hair when the lathe spindle is slowly rotated.

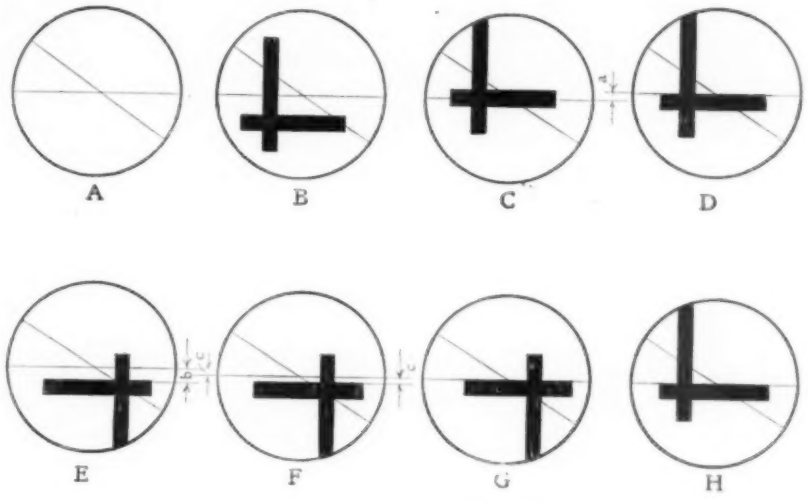


FIG. 4. CENTERING WORK ON THE FACE PLATE

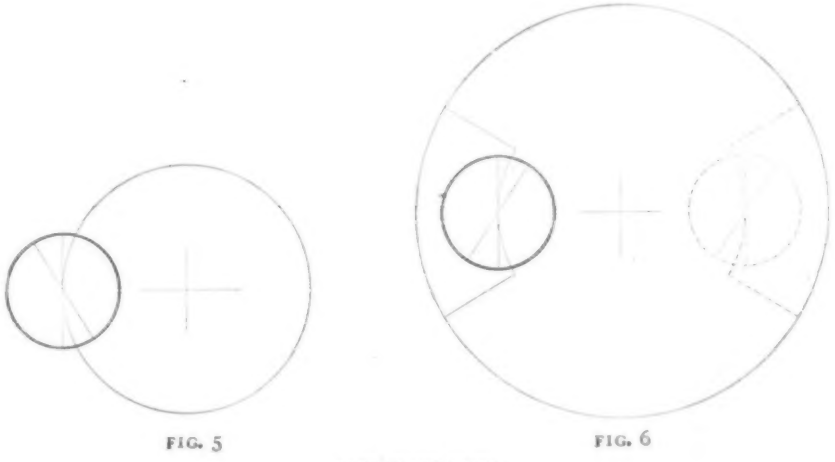


FIG. 5 FIG. 6

FACE PLATE WORK

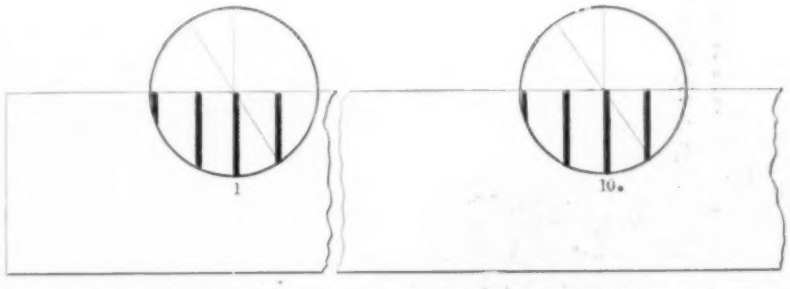


FIG. 7. SHOWING CROSS HAIRS SIGHTED ON SCALE GRADUATIONS

Measuring the Radius of A Segment

While we are considering the use of the microscope in connection with face-plate work, one other example may be cited showing the convenience of this instrument. Suppose we have, as is indicated in Fig. 6, a segment to be bored out to a given radius. When there are a number of such segments, they may be placed on the face plate, bored out and calipered precisely as an ordinary ring would be bored and measured; but where there is only one piece to machine, the proposition is an entirely different one. The usual expedient is to bolt on a piece of scrap iron opposite the segment being machined. With a microscope attached to the cross slide, we may test the correctness of the work by bringing the slide forward until the vertical hair is tangent to the arc bored out as shown in Fig. 6; the face plate may then be turned half over and the cross slide moved to the rear (counting the turns of the screw and reading the micrometer graduations) a total distance equal to twice the required radius of the work, or in other words equal to the diameter swept out. The microscope and the work in this second position are indicated by the dotted line, Fig. 6. If the piece is turned out to the right radius, the vertical hair will be tangent to the arc in its second position, just as it was when tested previously at the front of the center. With an accurate screw for operating the cross slide and the graduated collar thereon, we thus have a very handy means of calipering work, either external or internal.

Comparing Lathe Feed Screws with a Standard Scale

The half-tone, Fig. 2, shows a standard scale clamped on the face plate of the bench lathe. This represents a convenient means of testing the accuracy of the cross-feed screw with the scale, or *vice versa*, testing the scale against the screw. For a job of this kind where the lines have considerable width, it is probably better to focus the vertical hair on one side of the line, as indicated in Fig. 7. The microscope may then be moved transversely, by the cross-feed screw, bringing the vertical hair to the corresponding edge of the different lines; any discrepancies between the scale and the screw will, of course, be readily seen. Similarly the longitudinal-feed screw may be tested by placing a standard scale at the back of the bed and focusing the microscope thereon by mounting it in a vertical position.

Inspection of Threaded Work

Figs. 8, 9 and 10 show a way of testing the accuracy of taps or other threaded work by comparing with the lathe lead screw. A tap is likely to change more or less during the hardening process, and it is oftentimes very desirable to know just what the actual change in the lead amounts to. Mr. Warman's instrument, in Fig. 8, is shown focused on the thread of the tap held between the lathe centers. The field and the portion of the work coming therein is indicated by the sketch, Fig. 9, where the microscope tube is twisted in its holder sufficiently to bring one hair into coincidence with the helix of the thread; although the top of the thread when magnified has a rounded appearance, there is little difficulty in setting the microscope cross hair central with the actual top, as a very small amount off center is easily detected. If the carriage is moved along by the lead screw, the cross hair as brought successively over the different threads will show any error in the work as compared with the lead screw. When the microscope is placed on the compound rest, having a micrometer dial on the screw, the actual distance from center to center of the threads may be tested; the total error between the two most widely separated threads on the job may also be found directly. Sometimes it is more convenient

to set the microscope as suggested in Fig. 10, one cross hair in this case coinciding with the edge of the slope on the threads. In both sketches, Figs. 9 and 10, it will be seen that a slight error is indicated as detected by the second setting of the instrument.

A Worm-thread Tool and a Fly-cutter Job

Fig. 11 shows an application of the microscope in grinding a worm-thread tool. The tool is first ground to the proper angle, that is, 14½ degrees with the sides of the shank, leaving the flat at the end too narrow. Then the tool is set in the chuck, the microscope placed vertically in the slide rest and brought to bear in succession, at points *A*, *B*, *C* and *D*. The longitudinal slide for this job is moved until the cross hairs when focused on opposite edges of the tool, as at *A* and *B*, give the correct width at the pitch line for the tool, as read on the cross-slide micrometer collar. The microscope is then moved to the position indicated at *C*, that is, about the middle of the width of the tool at the pitch line, and by means of the longitudinal screw the distance to the end of the tool, as at *D*, is found. After the microscope has been adjusted, as at *D*, the actual length of the tool from the pitch line to the end is read off from the micrometer on the slide-rest screw, and from this distance may be subtracted the correct length from pitch line to end of tool (as found by calculation, or from a table), showing at once how much must be ground off the end of the tool to bring it to standard width.

Mr. Gribben, in making a fly cutter to cut a slot of a certain width, used the microscope as indicated in Fig. 12 to test the working width of the cutter. The latter was held in the lathe chuck, with the microscope held vertically in the slide rest, testing successively as indicated in the two views in Fig. 12, sighting first on the cutting edge of the cutter toward the front of the lathe, then turning the spindle and cutter halfway over and sighting on the same edge of the cutter turned toward the back of the lathe. The width of path which the cutter would describe in operation was therefore shown by the

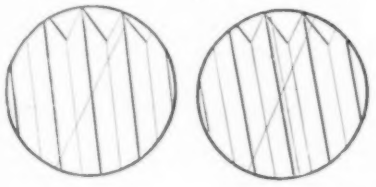


FIG. 9

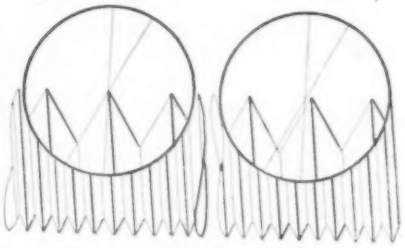


FIG. 10

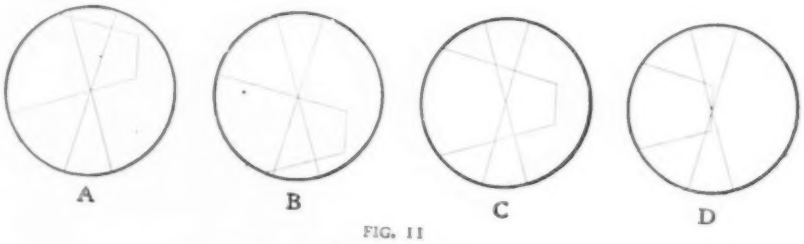


FIG. 11

THREAD AND THREAD-TOOL INSPECTION

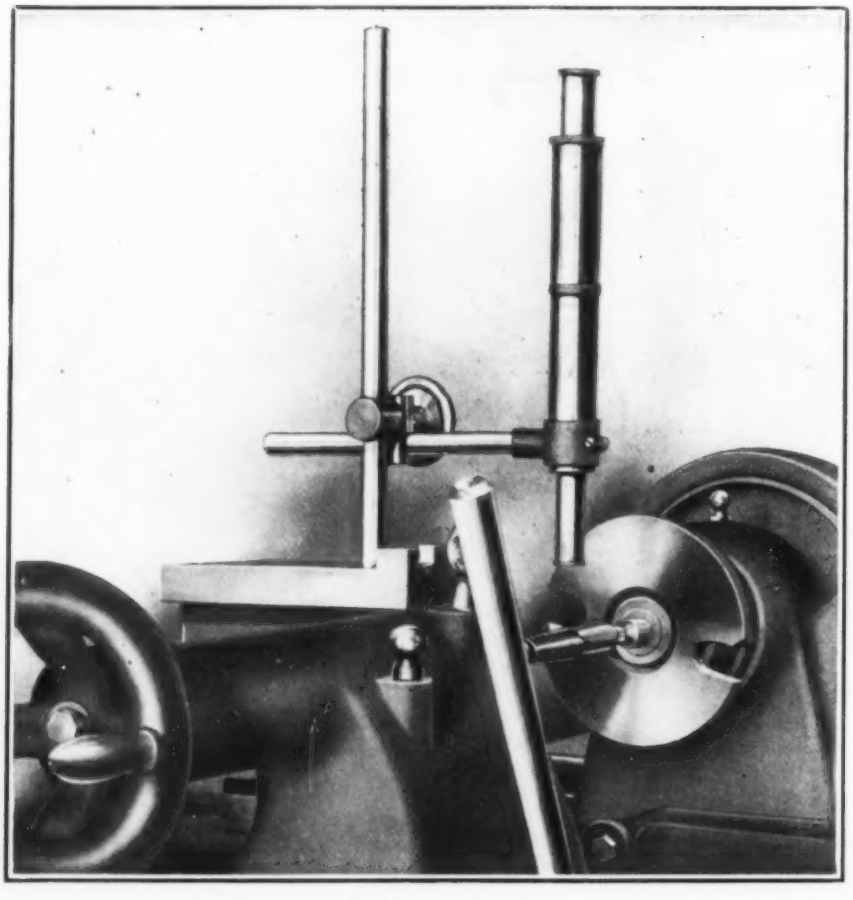


FIG. 8. COMPARING THREADS

reading of the micrometer on the cross screw in adjusting the microscope from the first sighting position to the second.

Finding the Distance Between Lathe-bed V's

Some time ago Mr. Gribben wished to make a templet for his bench lathe ways and first naturally wished to find the center distance between the front and rear V's. For this purpose he made a shoe, shown in Fig. 13, which was cut out and scraped to fit the V's, as indicated. Striking a line on the upper face of the shoe and setting his microscope vertically on his slide rest, the shoe resting on the front V, he adjusted the rest until the point of intersection of the microscope cross hairs was over the line on the shoe, noting the reading of the graduations on the cross-slide screw at this point. The shoe was then shifted to the rear V, the slide rest run back and the microscope again sighted on the line of the shoe. The exact distance moved (which was the exact center distance) was of course readily determined by keeping track of the number of turns and parts of a turn of the slide-rest screw.

A Ball-race Measurement

Fig. 14 shows another interesting scheme, namely, measuring the diameter of the race in a ball bearing which apparently was made too small for the num-

ber and size of balls used. The bearing worked improperly, and it was evident that the balls were being crowded. The minimum diameter permissible, that is, a diameter which would bring all the balls in contact with one another, was readily determined by calculation; then the actual diameter of the race was found by measuring with a microscope mounted vertically on the slide rest of the lathe, the ball race being clamped to the bed of the lathe in horizontal position and containing one ball only. First the ball was sighted, as at *A*, Fig. 14, with one cross hair tangent to the inner side of the ball; then the latter was rolled around to the opposite side of the race and the slide rest adjusted by the screw until the same hair was again tangent with the outside of the ball, as at *B*. The distance the microscope was moved was shown by the micrometer collar. This test showed that the race was actually 0.0016 too small in diameter, or that much less than the proper diameter as determined by calculation.

Work on the Surface Plate

By referring again to Fig. 1, some further idea of the convenience of the microscope for laying out and other surface-plate operations will be obtained. The disk clamped on the angle plate in this illustration has drawn upon its surface a line to which it is desired to mill or turn off the edge of the disk, for the purpose of leaving a flat edge at this point. It is desirable, therefore, to set this disk in such a position that the line shall be parallel to the bottom of the angle plate upon which the work will be carried while the operation of flatting off the edge is performed. It is obviously a very simple matter to focus the cross hairs at one end of the line, then slide the work to and fro past the field of the microscope, adjusting the disk until the line coincides throughout its length with the intersection of the cross hairs. This illustration will suggest a number of operations, in connection with tool-room work that come within the field of the microscope.

A Special Microscope Fixture

On the engraving machine built by the Keller Mechanical Engraving Company a four-cornered cutting tool is used, which is of rhombic section, so that two corners only do the cutting. The cutter is tapered through the greater part of its cutting length and rounded at the end, the amount of taper and the radius of the arc at the end varying with different classes and sizes of work. A corresponding taper and rounded end are given to the guide pin or tracer, which throughout the operation of mechanically engraving a die is held in contact with the model and operates a pivoted bar carrying the cutter for milling out the dies. The distance between the guide pin or tracer and the cutter is a variable quantity in accordance with the reduction required in the work, the model being made considerably larger than the die which is required. Consequently, the cutter itself is made of different diameter than the tracer, the difference of course varying with the amount of reduction required in the work. To facilitate the production of a cutter of the right diameter and also to make it possible to lap and oilstone the four-sided cutter so that the cutting edges shall be equidistant from the center, the fixture in Fig. 15 was constructed.

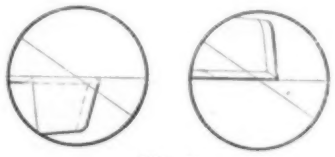


FIG. 12

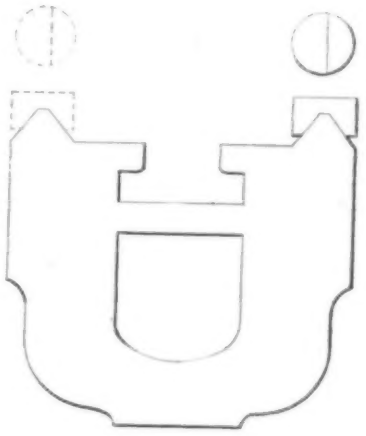


FIG. 13

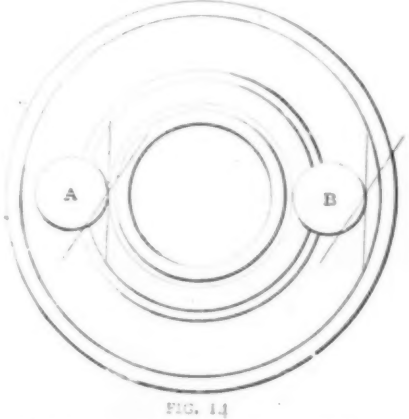


FIG. 14

OTHER OPERATIONS WITH THE MICROSCOPE

This fixture has an arm composed of two round bars, along which the microscope may be adjusted. The arm is pivoted at one end; at the other are a pair of stops between which the arm with the microscope is free to swing. A scale is placed on one of the bars which carry the microscope, corresponding to a scale on the engraving machine.

How the Fixture Is Used

The microscope is slid to the outer end of the swinging arm, and the stops which limit its oscillation are adjusted so that the cross hairs are sighted first on one side of the tracer; upon swinging the arm to the other side, they are then on the other side of the tracer, as seen in Fig. 16, which illustrates the scheme diagrammatically. The tracer itself is placed in a V-block on the base of the fixture, as shown in the photograph. Now to determine the width of cutter to use with this particular tracer, knowing the reduction required, the microscope is adjusted along the scale until the graduation indicating the required reduction is reached.

In the diagram, Fig. 16, the microscope is shown at the left-hand end as first focused on the opposite sides of the tracer; the position of the microscope when adjusted halfway between the original setting and the pivot is also shown, with the cross wires focused on the cut-

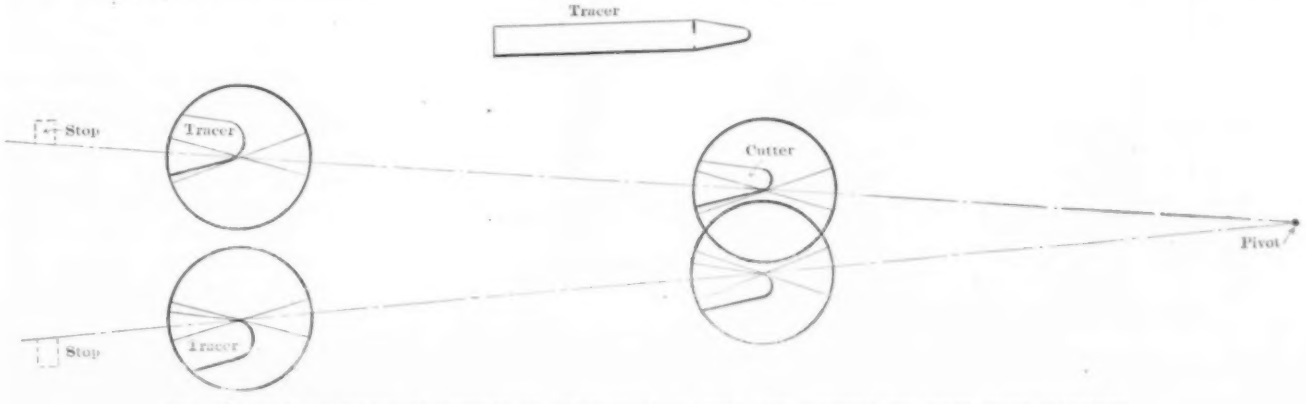


FIG. 16. DIAGRAM SHOWING METHOD OF INSPECTING TRACERS AND CUTTERS FOR ENGRAVING MACHINE

ter edge. This setting is, of course, for testing a cutter one-half the size of the tracer. The cutter is held in a draw-in chuck which is placed bodily in the engraving machine and which is removed with the cutter when the latter is to be ground. This chuck is placed in an indexing fixture, and the microscope is sighted first on one corner of the cutter and then on the one diagonally opposite to see if the diameter is correct. Each cutting edge is inspected by turning around the holder which carries the cutter, one cutting edge after the other thus being brought under the microscope. In this test each face of the cutter is oilstoned freehand until brought exactly to coincide with the cross hair of the microscope, which shows that both cutting edges are equally distant from the center and must therefore cut alike. The indexing holder, shown in place in the fixture in Fig. 15, is not the device referred to, but is of somewhat the same nature.

Convenience of the Fixture

It will be evident that this fixture is very handy in making comparative tests. No matter what the curvature of a tool may be, the adjustable stops may be set so that when the microscope arm is swung to either side one of the cross hairs will come tangent with the curve; any tool which it is desired to duplicate may be satisfactorily tested in this manner. The settings that are possible along the scale also make it just as convenient to produce a tool smaller or larger by any required amount than the model. A micrometer head and spindle are attached at the outer end of the swinging bar, so that the microscope may be adjusted by thousandths along the bar on which it is mounted.

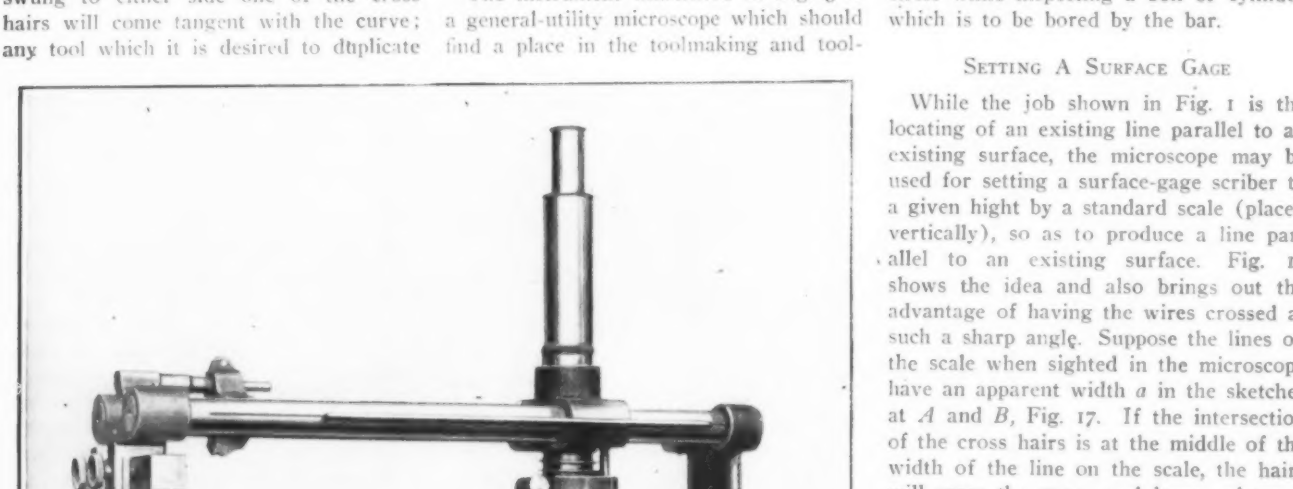


FIG. 17. SETTING A SURFACE GAGE BY THE MICROSCOPE

This is also a convenient fixture for testing taps and other threaded work, graduated scales, etc., as the microscope may be shifted by means of the micrometer screw and give settings varying by thousandths and fractions of thousandths.

A Handy Microscope

The instrument illustrated in Fig. 3 is a general-utility microscope which should find a place in the toolmaking and tool-operating field. Aside from the several ways already mentioned in which it may be used, there are any number of places and machines where it should be a convenient instrument. In testing the running accuracy of a milling cutter, for instance, it may be sighted on the corner and top of the tooth and the spindle then pulled around by hand, while each tooth is examined successively to see if it be high or low. Another place where this instrument could be used to advantage is in setting a planer tool to hight, first sighting on a scale on the desired graduation and then on the point of the tool. Owing to the V in the base block, it is possible to place the instrument on a boring bar and swing it about in an arc of a circle while inspecting a box or cylinder which is to be bored by the bar.

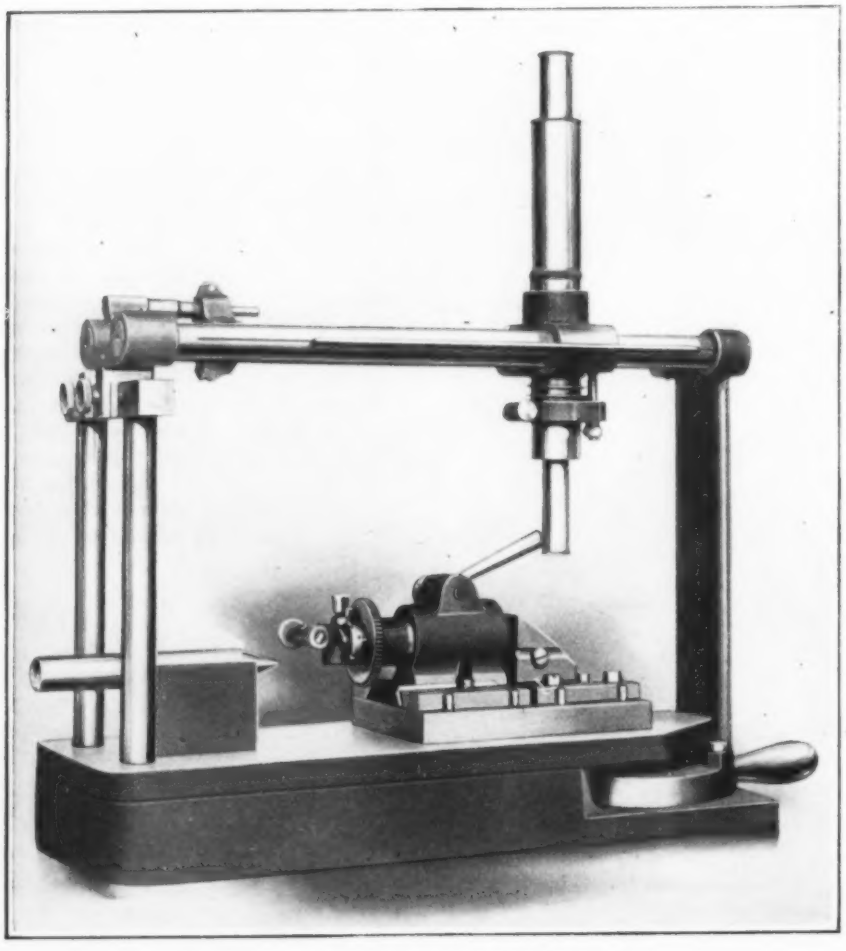


FIG. 15. A SPECIAL MICROSCOPE FIXTURE

Setting A Surface Gage

While the job shown in Fig. 1 is the locating of an existing line parallel to an existing surface, the microscope may be used for setting a surface-gage scriber to a given hight by a standard scale (placed vertically), so as to produce a line parallel to an existing surface. Fig. 17 shows the idea and also brings out the advantage of having the wires crossed at such a sharp angle. Suppose the lines on the scale when sighted in the microscope have an apparent width *a* in the sketches at *A* and *B*, Fig. 17. If the intersection of the cross hairs is at the middle of the width of the line on the scale, the hairs will cross the upper and lower edges of the line at equal distances from the center, as in the sketch at *A;* if we conceive lines like *b b* passing through the points of intersection of the cross hairs with the edges of the scale line, these lines will be vertical, as indicated. The sketch at *B* indicates the effect when the cross hairs are not central with the edges of the scale line, the lines *b b* here being at a considerable angle with the vertical.

When the microscope is adjusted central with the desired line, the scriber block may be adjusted until the point of the scriber lies between the cross hairs of the microscope, as at *C*, in which position it will be at the desired hight for scribing the line on the work. It will be apparent that the scriber must be in a horizontal position when setting the point properly by the opening between the cross hairs.

A Comparison of the Productive Values of High-speed Tool Steels and Carbon Steels

By George Bilham

That high-speed machines, or, to speak correctly, machines of high power in combination with high-speed air-hardened tool steels, are a great advantage and reduce the time and cost of all work to which they can be applied few will be disposed to deny, and considering the data we have to prove it the value of these two important factors in modern mechanical engineering can hardly be disputed.

In Vol. 30, Part 1, page 697, "English Machinist" seems to have knocked up against the "productive value" of these modern aids to progress in the machine shop. To arrive at the difference in productive value between the old and new methods, he makes a comparison which goes part of the way toward demonstrating the value of the old method and includes a change in the wages rate which may, in the one case, be permissible, but which would not apply to cases generally; to arrive at the relative value of the two methods some definite basis should be used, preferably one with a uniform wages rate per hour, otherwise the result would be unreliable. With such varied conditions to contend with as generally exist in machine shops, perhaps it would be as well to deal with certain specific cases which, while not covering the whole ground, will form a reliable basis for calculation.

As regards the saving effected by the use of high-speed steels in combination with the older types of lathes, planers and slotting machines, the problem is a little difficult of solution. Under certain conditions high-speed steels will be found very useful in machining the higher carbon steels which have come into general use in the engineering trade. Often machines, which are speeded from 18 to 25 feet per minute for cutting soft machinery steel with water-hardened carbon tool steels, have a reserve of power sufficient to enable them to machine the harder steel at the same speeds and feeds. However, one often hears the complaint that "this material is very hard and I can do nothing with it even with high-speed steel." It is often overlooked that one of the chief advantages of most of the present high-speed steels is that it will continue to cut long after the ideal cutting edge has been worn off and sufficient heat has been generated to ruin a tool made of ordinary water-hardened tool steel.

One important factor regarding the older and slower speeded machines should not be forgotten, which is that on a good class of general work, say of 0.3 per cent. carbon forged steel, the finishing operations, which necessarily entail slow speeds and fine feeds to obtain accuracy of size with a good finished surface, will be as quickly and accurately performed as on a high-powered machine. The power required for cutting is very small compared with that required for roughing operations. The cost of the high-speed steels seems to be one factor affecting their use, but if those who object to them on these grounds were to analyze the work done by a tool of A. W., costing 180 shillings per hundredweight, as against, say, Bohler tough and hard, costing 70 shillings per hundredweight, it would be found that the difference in initial cost would be a negligible quantity as compared with the quantity of work produced in a given time. It should be remembered that both these steels have their proper sphere of work; although it is not possible to lay down a hard and fast rule, it may safely be said that under certain conditions in roughing-out operations, the high-speed steel will remove from two to three times as much material as a water-hardened tool steel under the same conditions. Under exceptional conditions there is no comparison. For instance, a lathe recently built by Buckton & Co., Leeds, will remove 0.5 per cent. carbon steel at the rate of one ton per hour at about 40 inches diameter with two tools. It will reduce the job to 37 inches diameter for a length of 40 inches in the time stated, necessitating a speed of 35 feet per minute with a feed of 1/5 inch per revolution. This is work undreamt of with the older steels.

When introducing the use of high-speed steels, care should be taken to reduce the overhang of the tool as much as possible. Most, if not all of them, fail under a strain such as is present when used as a parting tool in cutting through a thick plate or other piece of work. This necessitates the use of a long tool with the accompanying disadvantages of the overhang.

The use of high-speed steels in combination with high-powered machine tools, as on heavy lathes, planing and slotting machines, will, of course, effect a very great saving, especially in removing large quantities of material in roughing-out operations, but as previously mentioned does not show to advantage on the finishing operations. The time taken by the operator to perform the various operations while the machine is standing will vary for the same job in different shops, owing to the difference in method of shop management. In some shops the machinist has little or no assistance in handling heavy pieces, except from the use of the crane, as it is considered good practice to economize on non-productive labor, and to pay the higher rated producer to do

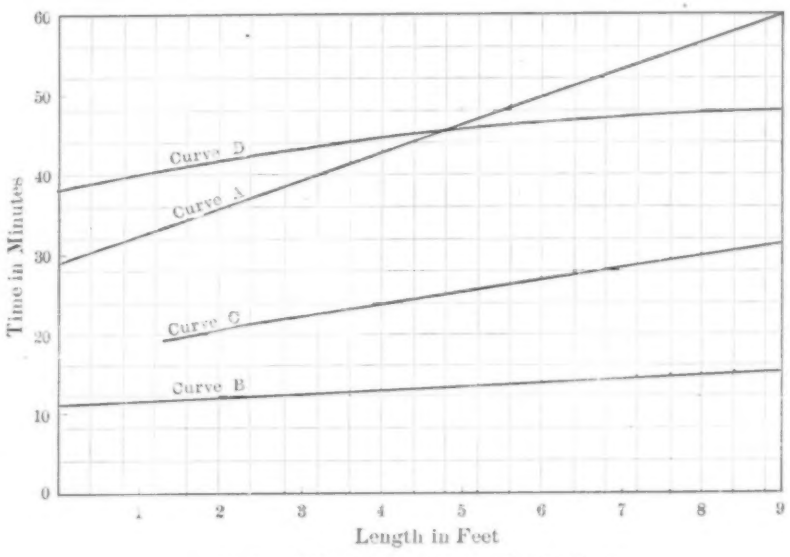


FIG. 1. PLOTTED DIAGRAM OF PLANER WORK

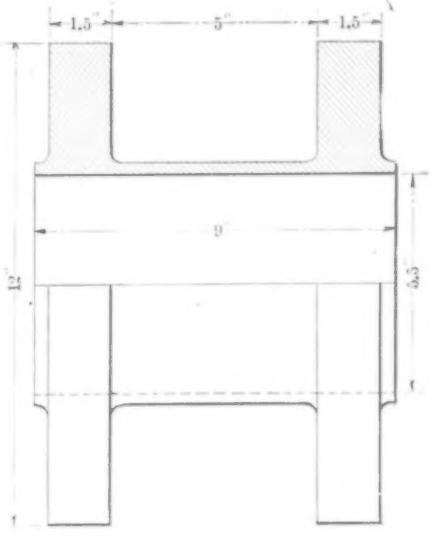


FIG. 2. A TURRET-LATHE JOB

work which might be done by a man at half his rate. Consequently the cost of the job is increased in proportion. Having recently plotted a diagram for the wages value of a set of similar planing operations on similar articles, it occurred to me to split up the value into machine time plus operator's time (i.e., the time taken by the operator as apart from the actual cutting time). This gave a diagram as in Fig. 1, which is a typical example of every-day practice in a general machine shop. The line *A*, on the diagram, represents the whole time taken on the operation with the machine running at an average speed of 18 feet per minute. The line *B* represents the operator's time, the space between the two lines is machine time. It will be seen that the diagram lends itself to the insertion of a third line at *C*, representing an average speed of 36 feet per minute with an increase of feed equal to 33 per cent. The line *B* remains the same, the operator will have the same amount of work-setting, tool-grinding and setting, gaging work and machine adjusting to do no matter at what speed the machine is running. The line *D* is the calculated percentage of saving in time and wages as shown by the increase in speed and feed at the line *C*.

As this type of machine is one of the most important met with in this connection, an analysis of the saving or loss effected is desirable. The diagram may be taken as typical of work which, though it has to be kept up to size within say 0.01 inch, is only rough finished or which is roughed out to be finished at another and later operation. If we take as a compromise an average saving in time of 44 per cent., we may arrive at the productive saving by comparing the annual expenditure on two machines for one of which the wage cost for a certain operation is represented by the line *A*, for the second by the line *C*. It should be understood that the percentages used are purely arbitrary and are based on those used by a first-class establishment.

As this is an example of planing-machine practice, suppose we assume one of the older type of planing machines to be the subject of comparison with a modern high-powered type of planer. Taking the older type of machine built seven years ago, say 5x5x15 feet at a cost of £500 or $2500, including erecting:

Allow for interest on the capital at 5 per cent.....	£25 or	$125
Allow for depreciation of the machine at 6 per cent.....	30 or	150
Allow for maintenance of the machine, including tools, 3 per cent.....	15 or	75
Power cost for a machine requiring four horse-power 0.7 of the total working hours 2500 = 1750 hours running time at 4 pence per hour, say	29 or	145
A total annual expenditure on the machine of.....	£99 or	$495

Comparing this with a modern high-powered machine of the present day, fitted with air clutches and all the latest improvements, of the same dimensions, at a cost of £1250 or $6250, including erecting:

Allow for interest on the capital at 5 per cent..	£62.10 or	$312.50
Allow for depreciation of machine at 6.5 per cent.	81.5 or	406.25
Allow for maintenance and tools at 4 per cent.	50.0 or	250.00
Power cost for a machine requiring 10 horse-power 0.54 of the total working hours 2500 = 1350 hours running time at 10 pence per hour	56.5 or	281.25
A total annual expenditure on the machine of.....	£250.0 or	$1250.00

This shows an additional cost per annum of £151 = 152.5 per cent. But as there is a time saving of 44 per cent., the actual machine cost for the same amount of work is only 56 per cent. of £250, which is £140. If we take into account the saving of 44 per cent. on the machinist's time at 10 pence per hour, £46, with the consequent saving on indirect expenditure, including shop labor and supervision, at 60 per cent. of machinist's wages, £28, a total of £74 is to be deducted from the machine cost, reducing it to £66, thus showing a total saving in productive value over the older machine of 33 per cent. and a time saving of 22 weeks, an important factor, as most contracts are determined on a time basis and not always on the lowest tender. The value of the time saved should of itself cause the doubting ones to stop and think, if they do not wish to give their competitors points in the race for work. From this may be deduced the following regarding this type of machine: First, that it pays to use high-speed steel for roughing out on the older type of machines, providing they have sufficient power to drive the cut; secondly, that when the modernizing of the plant is under consideration, the value of the older type of machine for the slower operations should not be overlooked; it is inadvisable to scrap them indiscriminately, although the amount allowed for depreciation through a long period has repaid the original cost of the machines and they stand at scrap value only; thirdly, that in buying new machines the best type is that which will produce the greatest amount of work in a given time, having due regard to the rate of depreciation and the cost of maintenance, as on a poorly constructed machine these two items might easily outweigh, through the cost of repairs and replacements as well as the

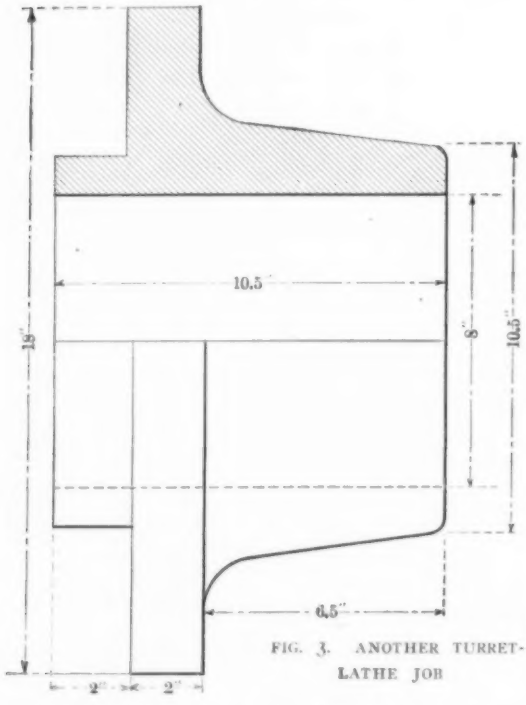


FIG. 3. ANOTHER TURRET-LATHE JOB

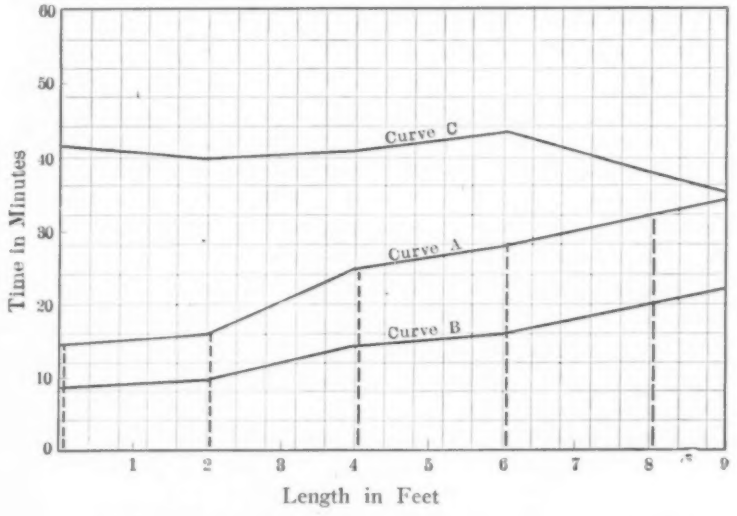


FIG. 4. PLOTTED DIAGRAM OF LATHE AND TURRET-LATHE WORK

time the machine is idle, any advantage gained by speed of production.

The use of high-speed steels in combination with high-powered machines specially designed to minimize the work of the operator and also to perform two or more operations at the same time, as in the case of turret lathes, shows a great saving which, as will be shown, more than justifies the extra capital expenditure and maintenance expenses involved. The use of the turret lathe effects many economies, as very often expensive forgings can be dispensed with and articles which can be machined from stock without causing undue weakness are almost invariably cheaper.

The economy of the turret lathe over the ordinary lathe when using carbon tool steel, through being designed to minimize the work of the operator, may safely be taken as at least 12.5 per cent. For instance, a collar having three internal sizes from 7 inches to 7.6 inches in diameter and 8 inches long was bored and the ends faced in 1¾ hours on the turret and in 2 hours on the lathe. This is typical of other work when only one tool can be used, except when large quantities of material are to be removed, and then the advantage increases. When two operations can be performed at the same time on the work in the turret, the saving is often 35 per cent. and in some cases as high as 40 per cent. The article shown at Fig. 2 was turned from 12 inches diameter stock on the turret in 9 hours, and in 15 hours on the lathe. The turret thus showed a saving of 40 per cent. in time and consequently wages. The article shown at Fig. 3 was bored and turned on the turret in 20 hours, and on the lathe in 32 hours, a saving in time and wages of 38 per cent. and on other jobs a like proportion. This is shown graphically in Fig. 4. Each article is represented by the vertical dotted lines, the time value in hours for the lathe by the line *A* and for the turret by the line *B;* the line *C* shows the percentage of saving. The drop to 37.5 per cent. at the eighth ordinate on the article shown at Fig. 3 is caused by its being slightly in excess of the capacity of the machine. It is therefore evident from the diagram that the advantage of the turret over the lathe is about 38 per cent. on work where two operations can be performed at the same time.

Let us take for comparison a lathe screw cutting and surfacing, 15-inch centers, 10-foot bed, built at a cost of £300 or $1500, including erecting:

Allow for interest on capital at 5 per cent.....	£15 or	$75
Allow for depreciation of machine at 6 per cent.....	18 or	90
Allow for maintenance, including tools, at 3 per cent.....	9 or	45
Power cost for a machine requiring 3 horse-power 0.71 of the total working hours 2500 = 1775 hours running time at 3 pence per hour, say.....	22 or	110
A total annual expenditure on the machine of.....	£64 or	$320

Comparing this with an up-to-date turret lathe of similar dimensions built at a cost of £550 or $2750, including erecting:

Allow for interest on capital at 5 per cent.....	£27.10 or	$137.50
Allow for depreciation of machine at 7 per cent..	38.10 or	192.50
Allow for maintenance including tools at 5 per cent.	27.10 or	137.50
Power cost for a machine requiring 7 horse-power 0.8 of the total working hours 2500 = 2000 hours running time at 7 pence per hour, say..	58.10 or	292.50
A total annual expenditure on the machine of.....	£152.0 or	$760.00

An additional cost per annum of £88 = 138 per cent.; but as there is a time saving of 38 per cent., the actual machine cost for the same amount of work (as produced by the lathe in one year) is only 62 per cent. of £152, which is £94.5. If we take into account the saving of 33 per cent. of machinist's time at 10 pence per hour = £38.15, with the consequent saving on indirect expenditure, including shop labor and supervision, say 60 per cent. of machinist's wages = £23.5, a total of £62 to be deducted from the machine cost of £94.5, reducing it to £32.5, a saving in productive value over the lathe of 49 per cent. and a time saving of 19 weeks on the year's work.

From this may be deduced the following: First, that on work which is particularly suited to the turret, an average time saving of 38 per cent. may be expected; secondly, on work where only one tool at a time can be used, the saving of 12.5 per cent. does not pay for the additional expense of the machine, thus showing a loss in productive value on that type of work, leaving a large field of operations open for the engine lathe on the general run of work. To obtain, however, the full advantages of all the various types of machines, some consideration should be given to the drawings as soon as completed, preferably by the rate fixer, before the work is issued to the shops.

L————, England.

Consul James E. Dunning, of Milan, reports that his office has received the official publication upon electrical motor force in Italy, in which the factory inspectors show the continued spread of that form of power. The consulate at Milan has frequently had occasion to comment on the rapid development of electrical force as a motor power in Italy, and particularly in the northern provinces, where the manufacturing interests center. The report for 1906 shows that at Milan alone about one-quarter of the total new work was put into operation, while the development through the Peninsula was general; 125 new electrical plants were built, and 114 extensions of existing plants were effected. The total of 239 new installations serves to indicate the condition of electrical development in the country as a whole.

The Growth of Cast Iron by Heating

On page 557 of the AMERICAN MACHINIST (October 17, 1907), there appears a communication on "Distortion of Steel in Hardening," in which the following statement is made: "It is also a fact that by actual measurement all metals will shrink when heated and cooled." This is not correct.

In a paper entitled "The Mobility of Molecules of Cast Iron," presented at the Atlantic City meeting of the American Institute of Mining Engineers, February, 1904, A. E. Outerbridge gave the results of many tests in heating and cooling various metals, including steel and cast-iron bars, showing that while steel and wrought-iron bars contract slightly when heated and cooled a number of times, similar bars of cast-iron expand or "grow" amazingly in cubical dimensions. Two test bars of gray cast iron were exhibited that had been cast in the same mold from patterns 15x1x1 inches. When cleaned there was a difference of only 0.003 inch between the two bars in length; they measured practically 14 13/16 inches long and 1 inch square section. One bar was kept in its original condition; the other was heated and cooled 27 times at a temperature of about 1450 degrees Fahrenheit for a period of about one hour at each heating, in a gas furnace, the bar being inclosed in an iron pipe to prevent oxidation and warping. Careful measurements were made after each treatment when the bar was cold, and progressive increase in dimensions noted.

When the bar was exhibited at the meeting, it was 16½ inches long and 1⅛ inches in each cross dimension, making a total increase in volume of 40.98 per cent.! This was subsequently increased to 46 per cent., after which no further permanent growth was obtainable by further heating and cooling. These companion test bars together with a steel bar showing shrinkages of nearly ⅛ inch in 12 inches after subjection to the same treatment as the expanded cast-iron bar, have been on exhibition in the museum of the Franklin Institute for three years.

The paper referred to was illustrated with numerous photographs showing castings of various kinds that had been permanently expanded, and descriptions were given of several practical applications that already had been made of the process. Since that time numerous other valuable applications have been made of the discovery which, by the way, was given publicity in the paper referred to without any attempt having been made to secure proprietary rights to its use through the Patent Office.

In this connection it may be admissible to refer briefly to an interesting statement that was made at a meeting of the Phila

delphia Foundrymen's Association several months ago by the president of the society, who said substantially that the discovery announced to this association three years ago, that iron castings could be caused to grow in length, breadth and thickness, had proved of considerable value. In one of the plants in which his firm is interested, several tons of steam-radiator castings had been condemned on account of being too short, owing partly to an error in the pattern and partly to excessive shrinkage of the iron. These condemned castings were all stacked in the yard ready for smelting in the cupola as scrap. Immediately after this discovery was announced, he directed that half a dozen of the condemned castings should be subjected experimentally to the heat treatment in an annealing oven; the result was as surprising as it was agreeable. By two inexpensive treatments the castings were caused to grow to *the exact length required,* and subsequently all of the remaining condemned radiator castings were successfully treated in the same way and all were put into service, the pipe couplings being then made without any difficulty in fitting, whereas, before the elongation of the castings, they could not be used at all.

A committee of science and arts, of the Franklin Institute, investigated the statements contained in the original paper and verified them all, finally awarding to the experimenter the Elliott Cresson gold medal "for original investigations and discoveries in iron." These facts seem to disprove the statement of our correspondent that it is a fact that by actual measurement all metals will shrink when heated and cooled.

Characteristics of Electric Motors

How the Work to Be Done Determines a Motor's Continuous and Intermittent Capacity and Its Design and Rating

BY EDWIN H. ANDERSON*

To perform a given amount of continuous work, the motor should be designed both electrically and mechanically for continuous duty, and rated on the continuous basis. Let us suppose that the work is driving a machine requiring 50 horse-power continuously, there being no variation in the load. The motor for this purpose should have a constant speed, capable of delivering 50 horse-power continuously, with a temperature rise which will not injure the materials with which it is insulated, when operating under conditions of proper speed, voltage and ventilation.

Let us suppose the work consists of 50 horse-power for five minutes and 10 horse-power for 10 minutes; the cycle to be repeated every 15 minutes and the speed to be constant. The speed characteristics of the motor require a shunt excitation, that is, a definite exciting current in the field regardless of the load in the armature. The average load of the motor is:

50×5 minutes $=$ 250 horse-power minutes
10×10 minutes $=$ 100 horse-power minutes
Total ..... 350 horse-power minutes

$$\frac{350}{15} = 23.3 \text{ h.p. average.}$$

This average load will not produce the heating that the cycle will, for the reason that the copper loss varies as a square of the current. The root mean square or equivalent heating will be produced by the following:

$50^2 \times 5$ minutes $=$ 12,500 h.p. square minutes
$10^2 \times 10$ minutes $=$ 1,000 h.p. square minutes
Total ..... 13,500 h.p. square minutes

By dividing this over 15 minutes, we get the average square as 900, which is 30 horse-power. This is the root mean square load or a load which will produce the same heating, if applied continuously, as would the intermittent work.

Again, suppose the work is neither constant nor entirely intermittent. The motor must be designed with reference to both, and rated at a certain value continuously and a certain higher load for a given time. The specification of a motor for the intermittent work noted above would be one capable of delivering 30 horse-power continuously with normal temperature rise, and 50 horse-power as a maximum intermittent load. If the work to be done is the same as given above, except at 50 horse-power, the revolutions per minute of the armature should be 500; if at 10 horse-power the revolutions per minute should be 750, and, should the load be thrown off and the motor allowed to run free with full voltage applied, the speed must not be over 1000 revolutions per minute. The motor must therefore be able to deliver 30 horse-power continuously as before, have a shunt winding on the field to give a definite and sufficient field strength so that the speed will not be greater than 1000 revolutions per minute, have sufficient series-field turns so that when taking 10 horse-power of current the field will have sufficient excitation to cause the speed to be 750 and, when taking 50 horse-power of current, will further magnetize the fields so as to produce a speed of 500 revolutions per minute.

If we suppose the work required be 50 horse-power for five minutes at 500 revolutions per minute and 10 horse-power for 10 minutes at 1000 revolutions per minute, there being no time in which the motor runs without power the field may be entirely series and adjusted properly for the respective loads. The continuous capacity will still be 30 horse-power as before, may be so rated, and have an intermittent capacity of 50 horse-power.

Street-railway Motors

Should the work be that required of railway motors under ordinary street-railway conditions, there being no continuous load but a series of intermittent loads, the natural rating is the normal maximum intermittent load for which the motor is designed, both electrically and mechanically. By common usage this rating has become the horse-power output at the car axle which the motor will carry for one hour and not have a rise in temperature, as measured by thermometer, greater than 75 degrees Centigrade. The motor is started cold and run on the stand. The starting or pulling effect at the rating is usually the starting effect used in accelerating the car.

A motor of the usual direct-current series type may be looked upon as one which will deliver continuously about one-third of its hourly rating, or its hourly rating for one-third of the time, the cycle of operation being limited to, say, 10 or 15 minutes. The series characteristic which gives the high speed at light loads and low speed at heavy loads is ideal for street-railway work.

The intermittent loads of operating a car may be represented by the following table:

50 horse-power for 10 seconds, accelerating
40 horse-power for 2 seconds
30 horse-power for 6 seconds
20 horse-power for 20 seconds
15 horse-power for 60 seconds
No horse-power for 20 seconds, applying brakes
No horse-power for 10 seconds, stopped
128 seconds per cycle

The average horse-power output is as follows:

$50 \times 10 = 500$
$40 \times 2 = 80$
$30 \times 6 = 180$
$20 \times 20 = 400$
$15 \times 60 = 900$
Total = 2060 horse-power seconds.

The average horse-power over the whole cycle is, therefore,

$$\frac{2060}{128} = 16.1 \text{ horse-power.}$$

*Engineer, railway engineering department, General Electric Company.

The current, corresponding to the horse-power which will produce the same copper loss as in the above cycle, will be the root mean square as follows:

$$\begin{aligned} 50^2 \times 10 &= 2,500 \\ 40^2 \times 2 &= 3,200 \\ 30^2 \times 6 &= 5,400 \\ 20^2 \times 20 &= 8,000 \\ 15^2 \times 60 &= 15,500 \\ \text{Total} &= 34,600 \end{aligned}$$

The root mean square for 128 seconds is therefore 21.1 horse-power. The motor has been working on a voltage and current for 98 seconds out of the 128, or 75 per cent. of the time. The continuous capacity then may be approximately a current which corresponds to 21.1 horse-power (root mean square) based upon full voltage and an applied voltage which is 75 per cent. of the normal. This is approximate and not to be relied upon for accuracy. The method, however, serves to illustrate that there is a continuous current and voltage which could be applied to produce the losses and temperature rise of the motors in service. This continuous capacity, however, does not serve to test the motor on its full intermittent capacity at full voltage and, as stated before, it has become general to rate the railway motor on its intermittent capacity of 50 horse-power. The electrical and mechanical design is made with reference to the intermittent rating.

Characteristic Curves

Fig. 1 shows the characteristic curves of the usual direct-current series motor, such as used on street cars, hoists, cranes, and for intermittent work generally. The applied voltage across the motor is 500. The values of speed in revolutions per minute, efficiency, torque at one-foot radius and horse-power output at the armature shaft are shown as ordinates and plotted to amperes input to the motor as abscissas. It will be noted that the curves show the values in the accompanying table:

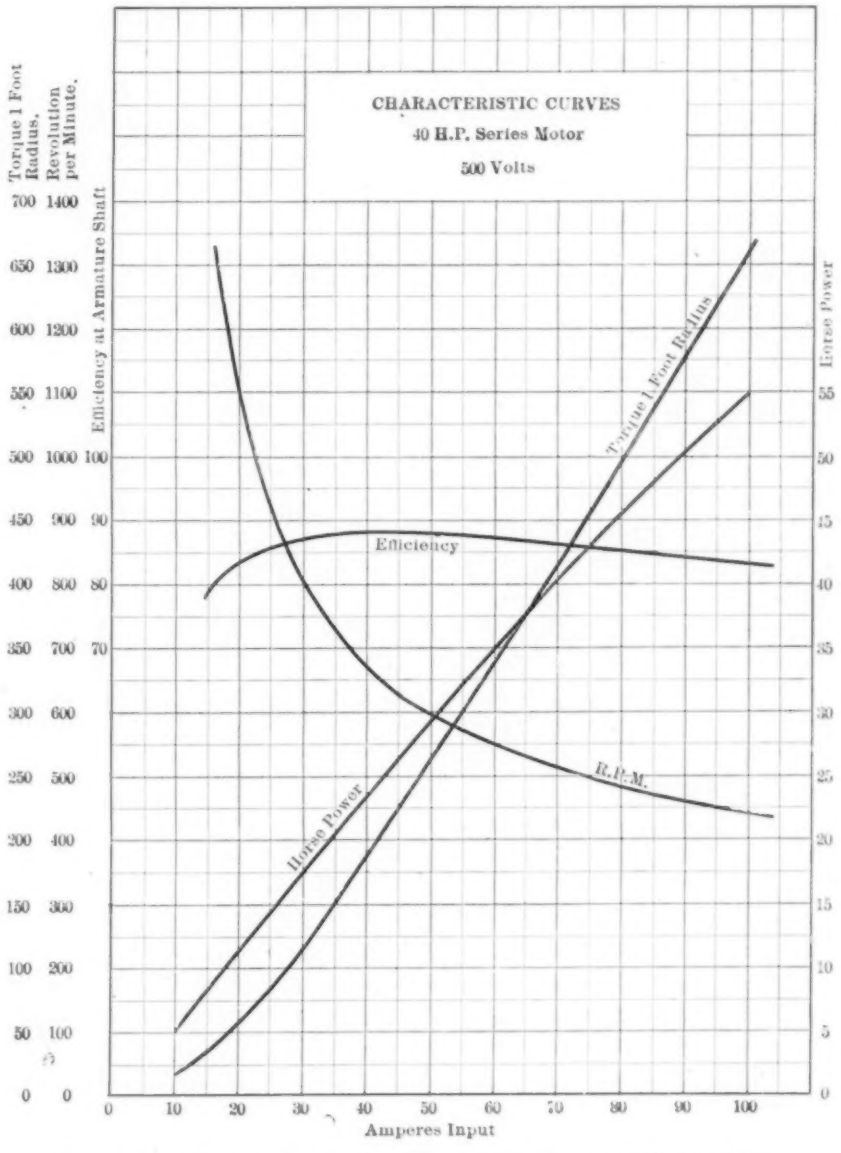


FIG. 1. CHARACTERISTIC CURVES OF A DIRECT-CURRENT SERIES-WOUND MOTOR

Amperes.	Efficiency.	Speed.	Torque.	H.P.
100	83	440	660	54.7
80	85	485	493	45.5
60	87	550	334	34.7
50	88	595	258	29.3
40	88	675	185	23.4
30	87	810	110	17.4
25	85	925	80	14.5
20	83	1100	55	10.8
15	78	1400	32	7.6

It is customary to represent the characterictics by curves instead of a table, as this serves as a table of indefinite subdivision, and, furthermore, is a picture giving at a glance a good general idea of the characterictics.

It will be noted that at the heavy currents the speeds are low, while at the light currents the speeds are high. The motor is series wound, that is, the current which passes through the armature also passes through turns of wire on the field magnets.

The measure of magnetizing force is ampere turns. Ampere turns is the product of amperes by the number of turns of wire around each field pole. When the magnetizing force is great, the strength of the magnetic pole is great, and *vice versa*. The applied pressure or voltage across the motor is resisted by two counter-pressures; first, that consumed in forcing the current over the copper wires, similar to friction in water pipes; second, a counter-voltage generated by the armature winding revolving in the magnetic field. This counter-voltage is proportional to the product of armature speed and the strength of the magnetic field. The torque at the armature shaft is proportional to the product of the armature turns, amperes and the strength of the magnetic field.

Should the motor be running at full load and delivering the torque at its armature and this torque be reduced, the motor will increase in speed, raising the counter-voltage and allowing less voltage to be consumed in driving the current through the windings. The current therefore is decreased. The decreasing of the current decreases the magnetizing force of the poles and in turn the strength of the magnetic field; this in turn requires the armature to run at a higher speed in order to generate the counter-voltage; thus the speed at large current input is slow and light current high, producing what is known as a series speed characteristic. With decreased field strength and current, the torque is reduced in proportion to the product of both. The motor almost instantly adjusts itself to the torque required.

We will assume 500 volts applied and 50 volts used in driving a given current through the winding. The counter-voltage produced by the armature revolving in the magnetic field would then be 450. We will now assume 250 volts applied for the same given current as above; thus 50 volts will be consumed in pushing the current through the windings and the counter-voltage produced by the armature will only be 200. Thus the speed at the lower voltage will be in a ratio of 200:450.

Should we now assume only 50 volts impressed on the motor, this will all be consumed in pushing the given current through the winding and no counter-voltage will be required. The motor will therefore not run but stand and deliver the same torque as it did under speeds with 250 and 500 volts applied.

The above, while elementary in a way, serves to show that the torque is practically constant for given amperes at various speeds corresponding to various applied voltages and, furthermore, serves to show how the speed of a series motor is affected by the application of various currents and voltages. To perform other work more intermittent than the railway motors, the rating would naturally be on the intermittent basis for a shorter time, say three-fourths or one-half hour, or in very intermittent work, such as lift or drawbridges, the rating may be on a 15-minute basis.

Any design must be made with special reference, both mechanically and electrically, to the maximum requirements, as well as to the continuous requirements, should there be any. Should the duty be continuous, the losses in the motor should be properly proportioned between the copper and the iron. The copper loss increases as the square of the current input to the motor, while the iron losses remain practically constant. Should the motor be designed for continuous operation and be operated on an intermittent overload, the copper loss becomes quite high and a better and cooler operating motor for intermittent work may have been made for the same weight and cost. In order to decrease the resistance of the copper circuit, a greater amount of steel may be used. This, however, naturally increases the iron losses but allows a lower copper loss for the same overload. In other words, a motor designed for intermittent work is considerably better than the motor designed for continuous load. A continuous-load motor is usually a small amount of iron with many turns of copper. The intermittent load motor has a large amount of iron with few turns of large copper.

The preceding explanation of the design and rating of motors is given so that the user of motors may appreciate that the character of the work to be performed should control the design; that motors designed for continuous duty are not well adapted for intermittent work and that motors designed for intermittent work are not well suited for continuous load.

Crane Motors

We will next consider the crane motor. The weight to be lifted requires at the speed an output of 50 horse-power at the armature shaft. The distance to be lifted is, say, 30 feet at 3 feet per second. The time is then 10 seconds with load. The crane is moved down the shop and the weight lowered by a very slight use of the motor. The crane is then run back and the cycle repeated every 100 seconds. The power is on 10 per cent. of the time, and the average load is 5 horse-power, The root mean square load, however, is 15.7 horse-power. The time that the voltage is applied is 10 per cent.; thus the average load, or the root mean square load at 10 per cent. of the normal voltage, becomes no test nor measure of the motor. The rating then is its intermittent capacity of 50 horse-power at full voltage for a given length of time. A motor properly designed for this load with respect to efficiency will have a low temperature rise in service, so the rating will properly be its intermittent capacity for some length of time as will produce the temperature rise in service, say, 30 minutes.

Draw-bridge Motors

We will now consider a motor for draw- or lift-bridge work. To lift the bridge requires 50 horse-power at the motor shaft for one minute, the bridge to be lifted every 100 minutes. The time for which power is on is one minute out of each 100, or 1 per cent. of the time. The average power of the motor is ½ horse-power and the average voltage applied 1 per cent. of the normal. Obviously no continuous rating at 5 horse-power (square root of mean square), or average ½ horse-power at 1 per cent. of the normal voltage would serve to test the motor. The proper test will be its intermittent rating of 50 horse-power on full voltage for a short time, say, 15 minutes. Obviously a motor of 50 horse-power continuous capacity is too large; what is needed is a motor with as small a continuous capacity as consistent with efficiency but of 50 horse-power intermittent capacity for 15 minutes.

Summary

In the foregoing I have endeavored to show that the characteristics of the work to be performed determine not only the design of the motor, but the method of its rating.

a. For constant and continuous capacity a motor should have a continuous rating only, with no overload of intermittent capacity.

b. For part continuous and part intermittent work a motor should have a continuous capacity with a certain overload or intermittent capacity.

c. Where variable speed is wanted, the motor should have a series field or a combination of shunt and series excitation.

d. For intermittent work, such as railway motors the field windings should be series and rated on their intermittent hourly capacity.

e. For crane and hoist motors the series field is required on account of speed characteristics, and the rating should be its intermittent capacity for a short time, say one-half hour.

f. For lift- or draw-bridge motors the series field is required, and the rating should be its intermittent capacity for a still shorter time, say 15 minutes.

Standards for Hardness and Tempering

By James Steele

I feel as though I ought to thank Mr. Pratt for his acknowledgment, on page 528, that his method of inspection is unreliable and unsatisfactory; but why he continues to doubt the standard that is in use in all good hardening departments, I cannot understand. Considering his first point, the characteristics of the steel: where do we find these characteristics and where are they most liable to be found? Surely not in cheap steel, such as files are made from.

As to the temperature and uniformity with which the steel is heated prior to plunging: is a file hardener any better qualified to get an even heat on a file than others? As a matter of fact he is often selected from unskilled laborers and put on a file-hardening fire.

As to the character and temperature of the plunging bath, there is not a tool cooled in a well regulated hardening room that has any more of a chance of having some parts of it soft than is the file. There is always sufficient heat left in a file to straighten after it is taken from the plunging bath. I have seen a great many file-plunging baths, but I have yet to see the first one that was arranged so that the bath could be kept at any given temperature while using it.

Then as to the rate of cooling: let me ask if in a bath such as is used ordinarily for hardening a file, if the bath would not be warmer on top, and is not the heel of a file heavier than the point? These are small points to consider, but with Mr. Pratt's comparative method of inspection a file cannot be tried the second time on the same point of the file. These elements are worthy of consideration by skilled men, such as the tool hardener, and they are surely worthy of consideration when used by men who are generally put on a file-hardening fire.

With a cheaper grade of steel and with the man unskilled; with the file heavier in one part than in others, in fact a continuous change of size, which Mr. Pratt admits will cause a relative difference in the hardness of steel—these surely will affect the file, the test tool he proposes, if such elements are to be found in our tools, as he states.

As to the change in sulphur and phosphorus by selecting a few bars at random from a lot of steel and testing a few pieces: this can be regulated very easily in the tempering.

Mr. Pratt says that with a given chem-

ical mixture a thin piece will get harder than one of considerable bulk, but I cannot agree with him. Only under certain conditions will this be found true. If heated and plunged precisely the same, of course it would then be true; but this is not the way to do such work, neither is it done that way by a tool hardener.

If a piece is thin, is cooled with the greatest possible speed and is as hard as is possible to make it, then it is hardened "hard." If a piece is of a larger bulk, it would be natural and proper, if it were wanted as hard as the thin piece, to give it all the forcing qualities known to the hardening department. These, if properly executed, would harden the larger piece as hard as the smaller one. For such force could not be applied to the smaller piece and handle the work with safety, which must always be considered.

Mr. Pratt has asked me to give the readers of the AMERICAN MACHINIST the precise heat for two or three of the leading brands of steel. This I fear would do more harm than good; but as I do not wish to evade, I will explain why I do not give the information asked for. First, it would not do to give a milling cutter and a drill the same heat that I do unless your drill or milling cutter were in the same condition that mine is when it comes to me to be hardened. Second, it would not do to give the exact heat that I give my tools unless you cooled just as I do. Third, unless you drew the temper just as I do, you would not have the same degree of hardness that my tools have. Fourth, if the tools were not working on the class of work that mine were, you might not have the best possible success in using them.

In order to use the precise heat I use in heating my work for hardening, it would be absolutely necessary to do the entire work just as I do mine, to expect to get the same results.

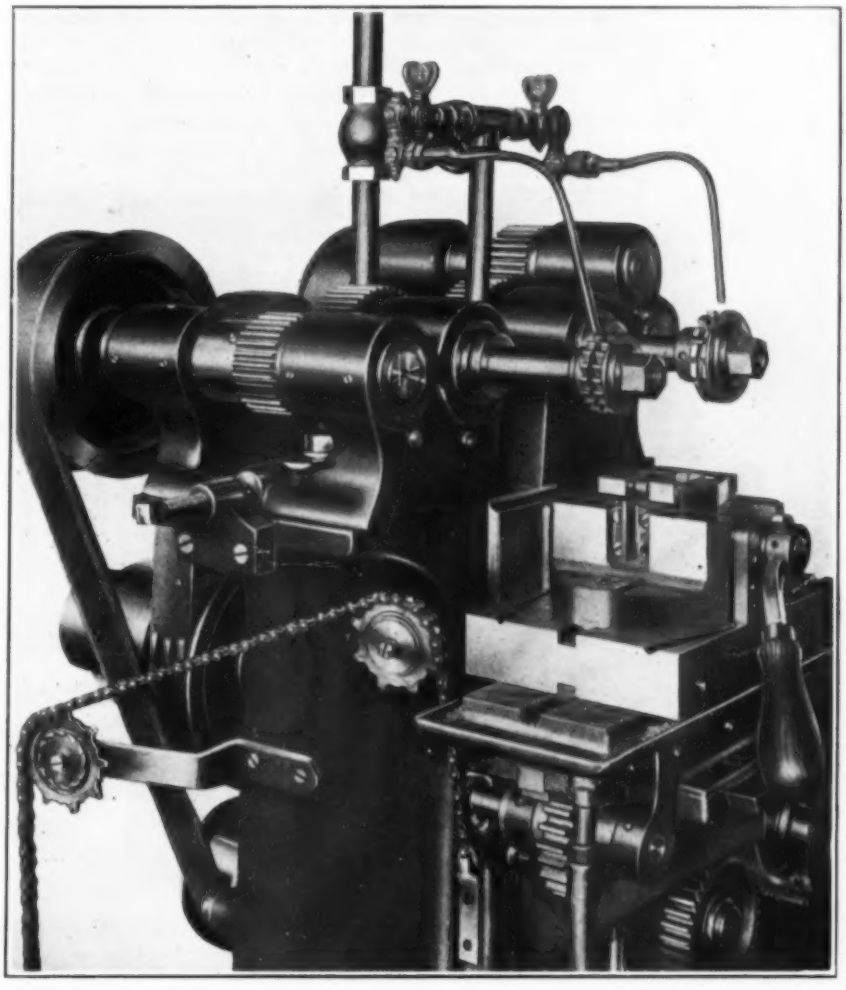
What I think would be of more interest is the way to produce this standard and maintain it. Before proceeding, I want to say that this can be done entirely without the use of a file, and a file should not be used. If the hardener cannot carry it through without one, he is not a hardener in the full meaning of the term.

First take a bar of steel; cut off eight pieces 4 inches long; take a cut over them to remove the scale. Number each piece, then harden, giving each piece a different heat and keeping a record of the heat given each piece. Then take as many reamers and taps, or in fact any tools, as are to be hardened, selecting one from each of the different tools, hardening one of each at heat No. 1; then continue heating them at the different heats until you get to No. 8, marking each tool with the heat given it. Then make a test of the tools at whatever they are intended for, and do not stop in making the test until the tool is put out of commission. Then break the tool that has done the best work and compare the grain with the grain of the test pieces, to see if the same heat will produce the same grain in tools of different shape and finish.

After comparing the grain, the heat can be selected from the test pieces, which should always be kept perfectly dry and clean. The variation of the steel will very seldom make any material difference, and hardness is not the only element that goes to make a good tool.

A Two-spindle Milling Machine

A rather unusual milling machine is shown with this, in which the two milling cutters are used either simultaneously or in sequence. It is being used very successfully by the Wyckoff, Seamans & Benedict Company in its large factory which builds the Remington typewriter. The machine is of the small bench miller type and was built by the Burke Machinery Company, of Cleveland, Ohio.



TWO-SPINDLE MILLING MACHINE

This two-spindle milling machine was originally designed for making simultaneous cuts on opposite ends of a bar, one of which is a form and the other a straddle mill cut. The bar is raised vertically between the cutters, a large hand wheel, not shown, elevating the knee, which is also counterweighted.

The table is arranged for longitudinal feed and the saddle for lateral feed, but these are not used on this job except for adjustment. In addition the two spindle heads are capable of slight adjustment with screws and check nuts parallel with the table.

One driving shaft is geared direct to the spindle, while the other has an intermediate gear in order that the spindles may revolve in opposite directions to accommodate the work passing between the cutters. Where the machine was intended to accommodate a wider range of work, it would be advisable to arrange the spindles so that the intermediate could be thrown out and the shaft geared direct, thus changing the direction of rotation to suit any particular job.

There are many applications for this machine which will suggest themselves to tool designers, a few of which are herein noted. The advantage of taking two cuts at once is, of course, apparent

and has been demonstrated by this original machine. It is also convenient on some work to pass the work under a roughing cutter, following it by the finishing cut before removing from the fixture.

There are also many small parts on which there are two or more cuts which must necessarily bear a fixed relation to each other, but on account of small gaging surfaces they are very difficult to move from one fixture to another and still preserve the accuracy required. By taking advantage of both vertical and horizontal movements it is possible with these two spindles to mill many such parts complete without removing them from the fixture.

The possibilities of the machine, of course, may be much further extended by the addition of power feed in one or more directions. In fact, the two-saddle idea as applied to a milling machine has never been fully considered, and it is more than probable that tool designers will find profitable uses for it which have not yet been thought of. That it is a practical idea has already been proved by its success in the very limited field to which it has been applied. S.

Drill Heads for Closely Spaced Holes

The Novel Mechanism of the Langelier Manufacturing Company to Drive Any Number of Drills Very Close Together

EDITORIAL CORRESPONDENCE

The drilling of closely spaced holes is always a problem that interests as well as puzzles the designer. By the usual methods of driving the drill spindles the smallest distance they can be spaced is determined by the diameter of the drill spindle and of the gear or pulley which drives them. In the present case, however, the space taken by the gears or belts is cut out of the calculation and only the size of the drill spindle and the chuck, together with the spindle bearing, need be considered. Even the diameter of the spindle can be considerably reduced below what is usual in most cases, owing to the method of construction.

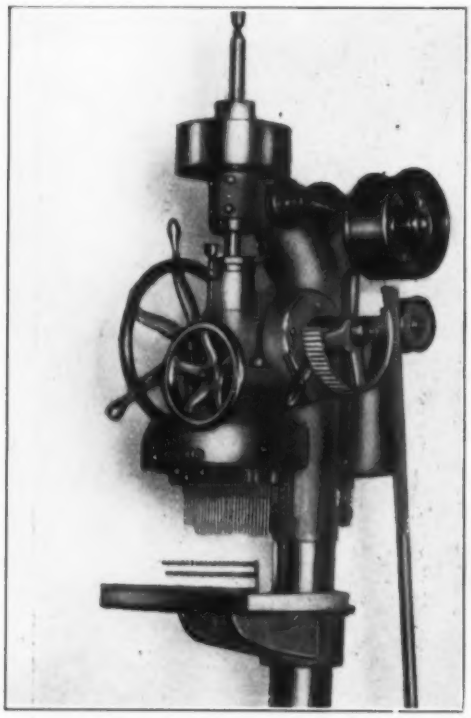


FIG. 1. DRILL PRESS FITTED WITH MULTIPLE DRILL HEAD

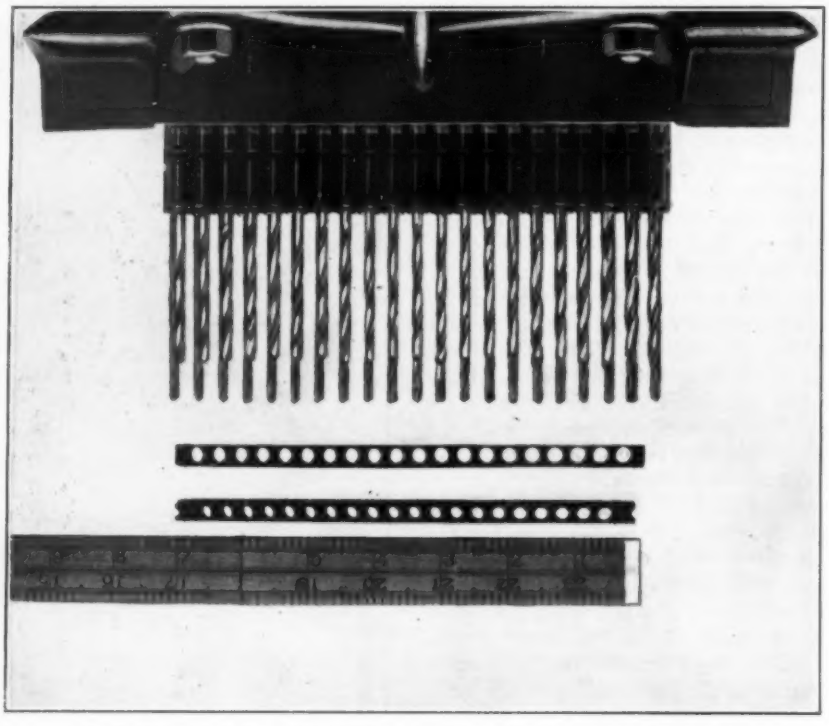


FIG. 2. TWO ROWS OF QUARTER-INCH DRILLS SPACED VERY CLOSELY

In Figs. 1 and 2 is an interesting drill head for drilling "jack strips" for telephone switchboards. It has twenty ¼-inch holes, spaced 0.334 inch in one strip and 0.375 inch in the other. As this allows only ⅛ inch between holes in the widest spacing, it is evidently impossible to hold a drill of this size or to drive it when so near its next-door neighbor, so they drill every other hole at the first operation and then drill in between them at the second pressure of the foot. Even this makes the center distance of spindles only 0.668 and requires pretty close figuring. This work is hard rubber and the drills are driven about 1200 revolutions per minute.

The drilling head is a complete unit in itself and is clamped into the bell-mouthed casting shown at the lower end of the main spindle guide. It can be removed at will and another and entirely different drilling head substituted for other work.

Fig. 3 shows another head and the work it is for, some of these pieces being shown and sizes given in Fig. 8, together with other samples of close drilling. This gives some idea of the variety of spacing and the variation in size of drill which can be used.

How It Is Done

The driving mechanism is shown in Fig. 4. The drill spindles are of tool steel, hardened and ground and run through the head *A*, which is of phosphor bronze. Each spindle has a crank on the upper end, as shown, the crank-pin or driving portion going into the phosphor-bronze driver *D*, with its main driving pin *C*. This pin enters a hole which is drilled

eccentric to the outside in the main driving spindle *B*, the amount of eccentricity depending on the throw of the cranks; in this case it is shown by the distance *X*.

The diagram at the right gives an idea of the lay-out of these five spindles in a straight, and the circles correspond to the just how the motion is given to each drill spindle, how they can be located at any point of the head *A* and drive plate *D* and still give each one its correct and positive motion.

Fig. 5 shows a machine with interchangeable heads for drilling the two

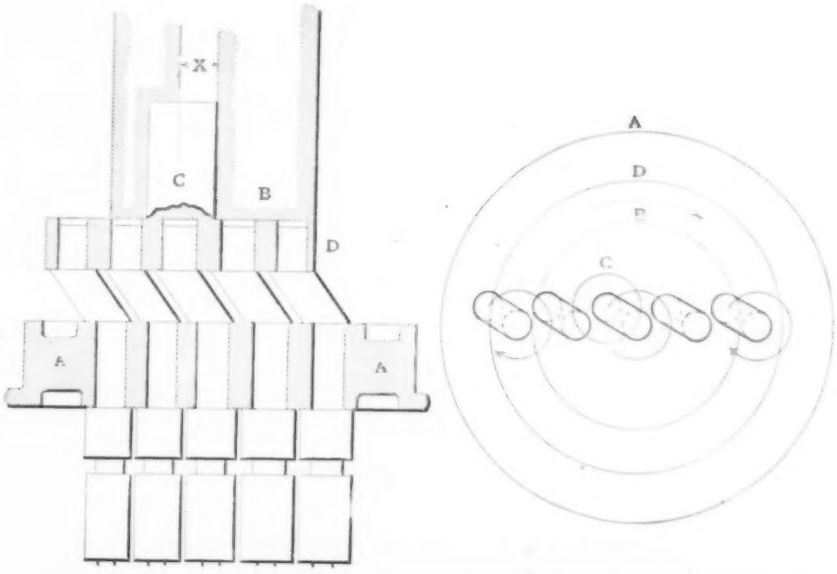


FIG. 4. SECTION OF DRILL HEAD THROUGH DRIVING CRANKS

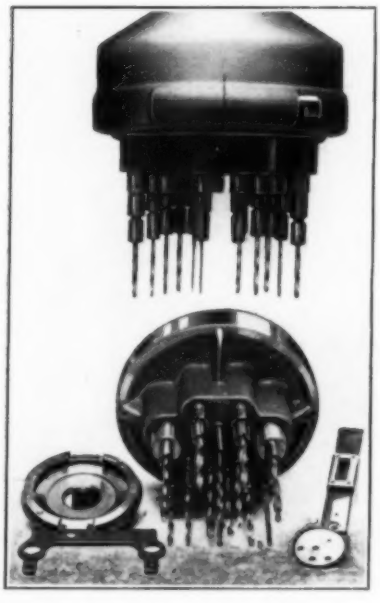


FIG. 3. DRILL HEADS FOR PIECES SHOWN

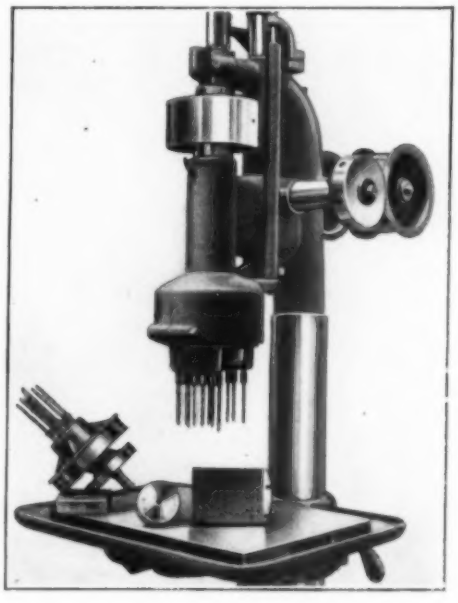


FIG. 5. DRILL HEAD WITH SMALL DRIVING CRANKS EXPOSED

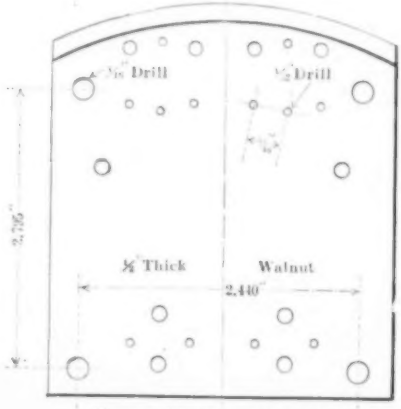
parts in the sectional view. When the spindle turns to the right, as shown by the arrow, crank-pin *C* carries plate *D* in the same direction and gives it a circular movement so that each small crank is turned once in its bearing every time the spindle revolves.

It will be noted how closely the cranks nest in together, which is the secret of the close spindle arrangement, as this is what makes it possible. If it is remembered that the head *A* is clamped firmly, as before mentioned, it will be easy to see pieces shown on the table. These are both of hard wood, and the drills are driven 2000 revolutions per minute. The drills vary from 1/32 inch to 3/16 inch, and each is drilled complete at one operation. When the detailed dimensions are studied, it is seen that the center distance of the outer holes in the circular piece is only 0.227 inch; in the other the nearest holes are only 5/16 inch apart. When we think of drilling these pieces complete in four and seven seconds, respectively, the time saved by being able to space mills closely seems to be almost without limit. Details are shown in Fig. 6.

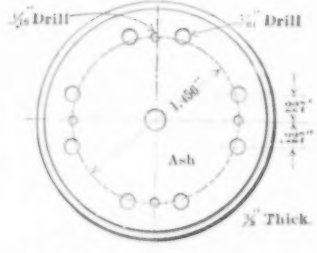
An Interesting Job

Some of these drill presses have been designed with four heads to avoid the necessity of changing the drill heads when more than one operation is necessary, as with the outlet-valve retaining disk for air compressors shown in Fig. 7. The details of operations on this piece are clearly shown and the successive steps are extremely interesting.

The first head drills the seven holes and countersinks them; then the second head drills the fourteen holes shown in



Time of Drilling, 7 Seconds.



Time of Drilling, 4 Seconds.

FIG. 6. TWO EXAMPLES OF DRILLING HARD WOOD

the second operation, using the holes already drilled to locate the small holes around the others. The piece is then turned under the second head until it has completed all these holes, as shown. The third head has the same lay-out as the first, with seven spindles which carry shell cutters to make the recesses shown at *a*. The last head is exactly like the third, excepting that the tools are combined drills and counterbores, the latter being adjustable vertically. The center drill is also a trifle longer than the rest, as in the first head, so that it may begin to cut first and act as a guide for starting the other drills. This completes the piece at one handling under the four heads.

The feed is a screw operated by hand, but with a knock-out clutch so that a quick return can be used. There is also

an adjustable screw stop for regulating depth of cut and an automatic oil feed so piped to the heads that all the cutting tools receive their proper supply of oil.

Drilling Gasolene-burner Plates

In the early days of automobiling when every little shop started to build steam wagons, we used to see the burner plate with its million little holes being drilled under a sensitive drill one hole at a time, sometimes with and often without a jig. Some of those who stayed in the business longer than the seventeenth day found that Langelier could beat that by long odds, that the burner plates could be drilled ten holes at a time and the jig question done away with. These holes were 1/16 inch in diameter on a 13/16-inch circle and had to be concentric with a 17/32-inch hole in which the air tube which connected the upper and lower plates was riveted.

The first operation drilled ten holes; then the plate was indexed around to drill between the holes already made and the second drilling completed the twenty holes. To insure the drills starting straight and to avoid the tendency to "run," for 1/16-inch drills are very flexible and a flat plate has no special inducement to start in the right place, a steady rest for the drills was provided so that they barely reached through this on starting; the rest was easy. On this work they were run 2000 revolutions per minute.

Examples of Work

Fig. 8 shows a variety of work with more or less detail as to speed of drill and time of operation, which should afford a guide in figuring on similar work. The scale at the bottom gives a good idea of the sizes of the pieces shown.

The arrangement of cranks for driving is an extremely interesting feature, and the speed at which they are run shows very clearly that the bearings must be ample or they would soon heat and get out of position.

In figuring up the cost of such a machine it is also necessary to count on the facts that no jigs are necessary and that the work is sure to be duplicate within very close limits, as well as saving time in putting work into the jig and other handling. The method is not only novel but has proved itself very successful in particular work, being in use in many of the best shops in the country and abroad. While they are usually furnished complete with the drill press, the drill heads are sometimes built to be used in regular drill presses which may be already in use.

F. H. C.

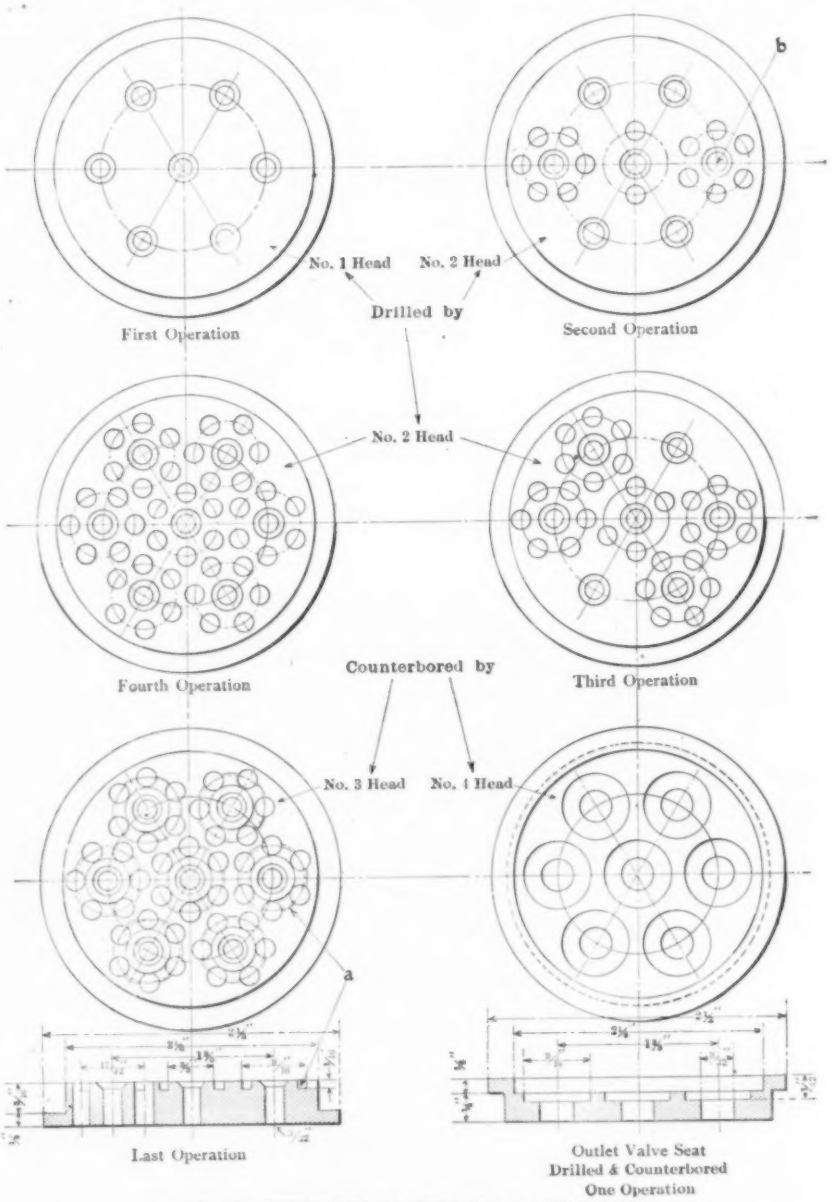


FIG. 7. OPERATIONS OF DRILLING A VALVE DISK

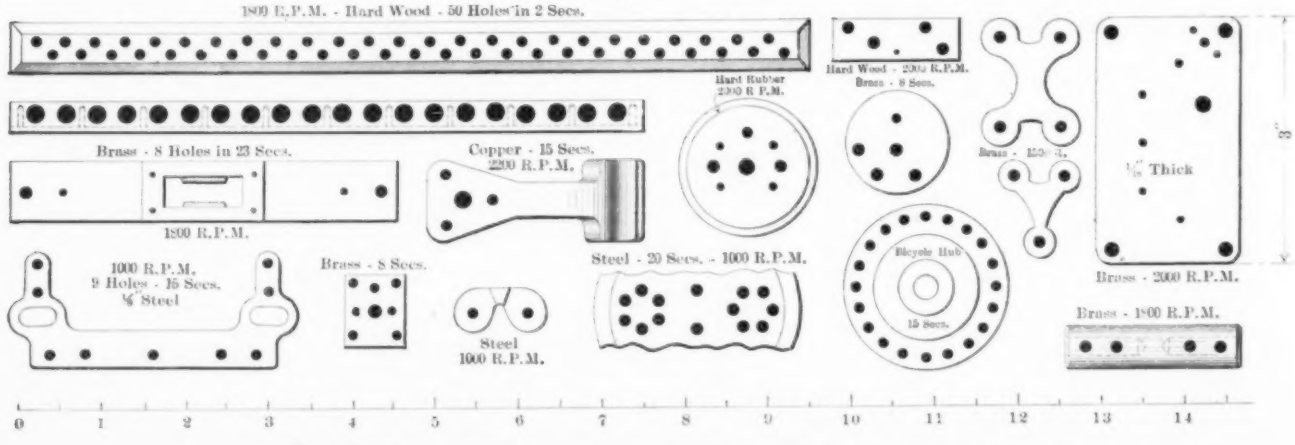

1800 R.P.M. - Hard Wood - 50 Holes in 2 Secs.
Brass - 8 Holes in 23 Secs.
1800 R.P.M.
Copper - 15 Secs.
230 R.P.M.
Hard Rubber
230 R.P.M.
Hard Wood - 230 R.P.M.
Brass - 8 Secs.
1000 R.P.M.
9 Holes - 16 Secs.
¼" Steel
Brass - 8 Secs.
Steel
1000 R.P.M.
Steel - 20 Secs. - 1000 R.P.M.
Bicycle Hub
15 Secs.
1/16" Thick
Brass - 2000 R.P.M.
Brass - 1800 R.P.M.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

FIG. 8. EXAMPLES OF WORK TO SCALE OF INCHES. EACH DRILLED IN ONE OPERATION

Test of Bearings—Hyatt Roller vs. Babbitted

A Comparative Test Was Made between Hyatt Roller and Babbitted Bearings Which Showed an Excellent Saving in Friction for the Former

BY L. P. ALFORD

Is it worth while to install anti-friction bearings on line shafting? This is the question which was put to me a few years ago in connection with the designing of the power-transmission machinery for large machine shops. Several types of anti-friction bearings were investigated, some in detail. Among the latter was the Hyatt roller bearing made by the Hyatt Roller Bearing Company, of Harrison, N. J. The method used to investigate this bearing, and the results of the test, form the subject of this article.

Purpose of the Test

Anti-friction bearings are of course in competition with the older forms of babbitted bearings; therefore it was essential to know what savings in friction or power losses could be obtained by their use. This information should be known for actual working shop conditions, not for conditions such as might exist if the bearings were compared by methods pursued in laboratory testing. The purpose of the tests which were carried out was, therefore, accurately to compare the behavior of a reasonable number of Hyatt roller bearings and babbitted bearings, under actual working conditions and for a reasonable period of time. Results obtained by such a procedure would be on a commercial basis, and therefore directly applicable to prospective shop conditions.

Method of Conducting the Test

A line shafting 2 15/16 inches in diameter and 152 feet long, supported by 20 bearings, was selected for the place of the test. This shaft ran at a speed of 150 revolutions per minute. It had not been relined or releveled for a period of about two years, and therefore reflected what might be considered average shop conditions in these particulars. Careful measurements of the friction loads of this line and the department which it drove were made, for a period of one week, under its original condition of lining and leveling, with its regular or ordinary babbitted bearings in place. These bearings were then removed, without disturbing the lining or leveling, and Hyatt roller bearings were installed. The Hyatt bearings had been so designed that they would enter the hanger frames of the babbitted bearings. The friction load of this arrangement was observed for one week. The shaft was then very carefully relined and releveled, and the friction load of the Hyatt bearings observed for a second week under the changed conditions. They were then run for two weeks longer, in order to give a test for the element of durability or wear. At the end of that time they were removed, the babbitted bearings were replaced and power observations taken for a period of one week, under the altered conditions of lining and leveling. Thus a comparison was established between the two sets of bearings for conditions of what might be called ordinary lining and leveling of the shafting, and for perfect conditions. The table, Fig. 1, shows the amount which the shaft was moved at each bearing when releveled and relined.

Bearings.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.	No. 13.	No. 14.	No. 15.	No. 16.	No. 17.	No. 18.	No. 19.	No. 20.
Up	0	0	0	0	3/32"	3/32"	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Down	0	0	0	1/64"	0	0	1/64"	1/32"	1/64"	3/64"	3/64"	1/32"	1/64"	1/64"	3/64"	1/32"	3/64"	3/64"	1/32"	3/64"
Right	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Left	0	3/64"	1/64"	3/64"	3/64"	1/64"	0	3/64"	1/32"	1/64"	0	1/16"	1/64"	1/64"	1/32"	1/64"	1/64"	1/16"	1/32"	0

FIG. 1. TABULATION SHOWING AMOUNT THE SHAFT WAS MOVED WHEN RELINED AND RELEVELED.

Description of the Bearings

The babbitted bearings were of the ordinary ring-oiling type and had been in use for about ten years. They were inspected prior to the beginning of the test and in general found in good condition. All showed signs of having had ample lubrication, and only a few were scored either in the lining or on the shaft. The Hyatt bearings were of a standard construction, each containing thirteen flexible rolls about 55/64 inch in diameter. The Hyatt bearings were slightly lubricated with ordinary machinery oil when they were installed.

The Testing Equipment

The testing equipment consisted of a 110-volt direct-current motor properly belted to the line shafting, and a set of measuring instruments indicating the current input. The motor was supplied with an efficiency curve, and it was a very easy matter to determine the horse-power output. All of the conditions in the department and in connection with the shaft to which the bearings were applied were kept uniform, with the exception of the change in lining and leveling which has been mentioned. The observations included, in addition to those necessary to compute the horse-power, the relative humidity of the air, obtained by the wet- and dry-bulb method, and the temperature in Fahrenheit degrees. It was known that belt tension and therefore the friction of the shafting in its bearings varied with the humidity. It was noted therefore in an attempt to establish a relation between these two factors. Observations were taken just before 7 a.m. and just following 6 p.m. Thus the friction load was observed when both cold and warm. Such a variation occurred, however, in the mornings' data that they were discarded in working out conclusions. The table, Fig. 2, shows one set of the observations, for the week of August 24 to August 29 inclusive, and is typical of all the observations which were made. The curves shown in Fig. 3 are plotted from the data of Fig. 2, and the shape indicates that a relation exists between the horse-power of friction and the humidity.

Measurements of the Rolls

The rolls in the bearing nearest the driven end of the shaft, or the one through which all of the power used in the entire shaft was transmitted, were accurately measured before the test and at the termination thereof, the duration of service having been 255 hours. Each roll was measured at five points: the end, the center and midway between. Two measurements were taken at each point on diameters at right angles to each other. The table, Fig. 4, shows the measurements of roll No. 3 and is typical of the variations found in all of the others. The primed dimensions were taken at the close of the test; the others before it commenced.

Deductions

A. Comparison of babbitted and Hyatt roller bearings for the original conditions of leveling and lining: The total friction load with the babbitted bearings installed

for the week of August 24 to August 29 was 9.88 horse-power.

The total friction load with Hyatt bearings installed for September 5 was 8.75 horse-power. The above isolated reading is taken for the Hyatt bearings, for the purpose of comparison, rather than the average of the week of August 31 to September 5, for the Hyatt bearings steadily improved in efficiency throughout that week. They were of course new and had never been used, when installed just prior to August 31.

The saving made by the Hyatt bearings over the babbitted bearings was 1.13 horse-power. The per cent. of saving made by the Hyatt bearings over the babbitted bearings was 11.4 per cent.

B. Comparison of babbitted and Hyatt bearings for conditions of new lining and leveling: The average total friction load of the babbitted bearings for the week of September 28 to October 3 was 10.46 horse-power. The average total friction load with Hyatt bearings installed for the week of September 14 to September 19 was 8.98 horse-power. The saving made by the Hyatt bearings over the babbitted bearings was 1.48 horse-power. The per cent. of saving made by the Hyatt bearings over the babbitted bearings was 14.1 per cent.

Date.	Actual H.P.	Relative Per Cent. Humidity.	Temp. Fahr. Degrees.
Aug. 24.....	10 10	75	60
Aug. 25.....	9.10	97	68
Aug. 26.....	9.68	89	61
Aug. 27.....	10.12	77	66
Aug. 28.....	10.37	63	75
Aug. 29.....	9.92	90	60

FIG. 2. A SPECIMEN SET OF OBSERVATIONS ON THE BABBITTED BEARINGS.

	Diameters.			
	A	A^1	B	B^1
	0.860	0.858	0.860	0.859
	0.860	0.859	0.860	0.859
	0.860	0.859	0.860	0.859
	0.859	0.858	0.860	0.858
	0.860	0.859	0.860	0.859
Average...	0.8598	0.8586	0.860	0.8588

FIG. 4. MEASUREMENTS OF ROLL NO. 3.

C. Comparison of babbitted and Hyatt bearings for the friction of the line shaft only: The friction load of the main shaft only in babbitted bearings was 2.28 horse-power. The saving in friction made by the Hyatt bearings, as shown under *B*, was 1.48 horse-power. The per cent. of saving of Hyatt bearings for the friction of the main shaft only was 64.9 per cent.

D. A study of the humidity and corresponding horse-power values shows that in a general way as the humidity increases, the friction load decreases and *vice versa*. While the results were not of such a character as to permit the drawing of general conclusions, still the effect of humidity seemed to be greater on the babbitted bearings than on the Hyatt bearings.

E. A study of the two sets of measurements of the rolls, of the bearing which transmitted the greatest load, shows that they improved in shape throughout the continuance of the test. Those that were somewhat elliptical before the test began were more nearly circular at its close. This should tend to improve the efficiency of the bearings, and a decrease in the friction load of the Hyatt bearings

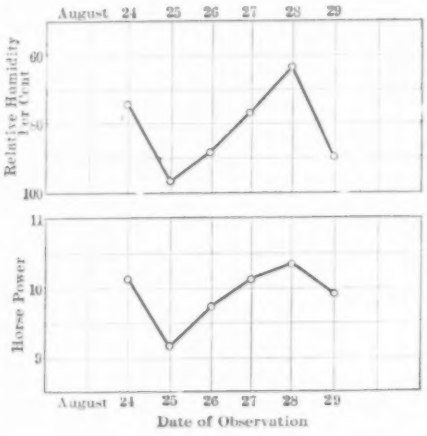


FIG. 3. COMPARATIVE CURVES OF HORSE-POWER OF FRICTION AND RELATIVE HUMIDITY

steadily took place during the first week of their running. No appreciable wear of the rolls took place during the 255 hours of the test.

As the result of this test, about 2000 Hyatt roller bearings were installed for main line shafting purposes in one plant. A considerable portion of this number have been in use for a period of over two years with success.

A New Feature in Machinists' Apprenticeship

The Cadillac Motor Car Company, of Detroit, Michigan, has added a new feature to its apprenticeship course. In order that the boys may become more efficient in reading drawings and as a consequence make fewer mistakes in their work, an hour and a half each day is spent in teaching them how to read and make drawings.

The class is conducted by the mechanical instructor who has full charge of the education of the apprentices, and is carried on in a room provided for that purpose. The boys are paid for the time just as if they were working in the shop. The company expects to get the money back with interest in the shape of more and better work. The class will only last through the winter months.

How Shall We Train Boys Who Are to Become Machinists?

By W. L. Hardy

About 35 years ago, when I was but a boy, I heard the late Mrs. Livermore deliver a lecture entitled, "What shall we do with our girls?" I have no recollection what Mrs. Livermore proposed to do with or for the girls, but it reminds me that the question, "What shall we do with our boys?" is being asked quite as persistently in these days. I feel that much that is said and written on the subject has as little permanent effect as Mrs. Livermore's lecture had upon me.

The discussion ranges all the way from suggestions for the revival of the good old-fashioned apprenticeship system to the trade school; good suggestions, most of them, and entirely practicable except perhaps for one thing; that obstacle is the boy himself. The old saying, "You can lead a horse to water, but you cannot make him drink," seems to me to fit the case very neatly. I think that it is unnecessary for me to go into the merits of the various plans suggested, but I do wish to point out that there need be no conflict of these systems, as some seem to think there is. I think that where conditions favor it the apprenticeship system is just as practical as ever it was; and certainly the trade school carried out on common-sense lines ought to flourish alongside the apprenticeship system and be in fact a valuable adjunct to it.

The general trend of the discussion seems to indicate that the modern machinist is not as well trained as the old-time prototype; it is said that the all-round man has gone. It may perhaps be true that there are not as many all-round machinists being trained today, in proportion to the number working at the business, as formerly; but this is an open question and hinges largely upon what one means by all-round. If it means a man who has performed every operation known to the machine business, he is and always was a rarity. If it means, as I believe it does, the kind of a man who, even if he has never performed an operation, can find a way to do it, then the all-round man is still with us and more are coming. It is impossible to do other than generalize along this line; but I believe that if one could compare the all-round men, as I have here defined them, who are employed in this country today with those of 25 years ago, the present would not suffer by the comparison. Certainly there has been an enormous increase in the number of machinists in the last 25 years, and it is not probable that all of these have been imported.

A number of years ago I had charge of the machinery in a factory. We had two machinists; one of them could find a

way of doing things and do them right, the other was an old-timer then and used to tell me of the fine jobs he had done, but I cannot remember that he ever did one satisfactory piece of work for us. His calipers would slip (?) or something else would happen, so that his jobs never came out just right.

Conditions Surrounding the Modern Boy

Those who have to deal with the modern boy will readily believe that he is not as good as boys were 40 or 50 years ago, and I think it quite possible that, generally speaking, this may be true (lack of sufficient knowledge on this point makes it inadvisable for me to make any definite assertion); but, whether the boy has changed or not, it certainly is true that his surroundings have greatly changed and, in my estimation, not to his advantage. There are now, in the cities and larger towns at least, a host of attractive distractions to absorb his time, money and energy that were practically unknown even 25 or 30 years ago. It is said, too, that formerly a more intelligent class of boys went into the machine shops to learn the trade, that nowadays the bright, brainy fellows want to be doctors or lawyers or the like. I am also unable to say just how much truth there is in this assertion, but practical experience with the boy of today leads one to the inevitable conclusion that what he is going to get out of the job in the way of pay figures very largely with him, and that what the work may lead to by and by is of relatively small importance in his estimation. This, however, can scarcely be considered strange in this dollar-chasing age, for herein the boy does not differ greatly from the rest of mankind. It may probably be safely said that the better the pay in the shop, the more attractive the work is likely to be to the more intelligent class of boys; also, it may just as safely be said of the boys who go to work in a machine shop merely because it is a job and who have no interest in the matter further than to get in their time and draw their pay, that they will always be a trial to everyone who has to do with them, and, while they may do certain kinds of work economically, no one need expect that they will ever become very good mechanics.

That a young man who is capable of becoming a good doctor or dentist should object to the conditions one finds in the average machine shop should astonish no one, although I met a successful young dentist some years ago who told me that he had served his time and worked several years in a machine shop and considered the experience that he acquired there as one of his best assets. It is safe to say, however, that this young man was something more than a mere machinist, and unquestionably there are a great many things about the average shop or factory to offend such a man. The working machinist, who expects to spend his whole life as such, does not usually belong to this class of men, and, as I understand the matter, it is this latter kind of man, the stayer, who is in demand in the shop at present.

Training for the Machinist

It seems to me that in discussing this question a clear distinction should be made between the training of young men who expect to become machine designers and engineers, and the training of those who will probably devote their lives to doing detail and repetition work; for, while the primary instruction of each may and probably should be identical, the scope of the instruction suited to the needs of the engineer will very soon widen beyond that suited to the absolute needs of the shop man. The former will need a comprehensive knowledge of machine-shop operations and processes which the latter does not necessarily need to have, for, in these days, it is the province of the engineer to decide upon what operations are necessary, what machines shall be used, and in what order, and with what tools these operations and processes shall be carried out. The province of the shop man is to perform properly all the details of the work as mapped out by the engineer and give his attention to the rapid production of work of the desired degree of accuracy; it necessarily follows that of the two the engineer has the greater need to be the all-round machinist. Whether the shop methods outlined above are the ideal ones or not will depend largely upon the point of view; but whatever our opinion about the matter, we must consider that they are here to stay. While I have apparently limited the scope of the necessary training of the shop man, or operative machinist, it does not necessarily follow that he shall confine himself to the proper operation of some one machine; on the contrary I think that a man makes a grave mistake in so doing, for the limits of the knowledge that he may acquire are the ones that he sets for himself and are measured exactly by how much he wishes to know.

Now the question whether the modern boy is worse or better than the boy of 25 or 50 years ago, or whether the old-time machinist knew more about the business than his modern prototype, is relatively of little moment; the problem is how best to train the kind of boy that offers his services for the work. The phase of it that demands the most serious attention is not how to get better material, but how to secure the best results from that at hand. Personally I am a firm believer in manual training and the trade school. I think that the training of the hand is of as great importance as the training of the mind, and, that, if such training be carried out on sensible lines, it will tend to the production of better workmen and better citizens. One noticeable thing about boys who apply for work in the shop is their woeful lack of a good primary education; while manual training will not in itself supply this lack, yet the tendency of it will be in that direction; for a boy who undertakes to make things soon finds the need of knowledge that he never before appreciated the use of. Here also the boy will acquire at least a slight knowledge of the manipulation of hand and machine tools, the more of it the better, and will probably get enough knowledge of the requirements of the work to enable him to decide whether he wishes to take it up for life. If he does, he will no doubt acquire enough skill to enable him at once to produce work of a certain standard when he goes into the shop. In the one case this relieves the shop of the trouble and expense of trying out a lot of boys who have no definite intention of following the business, and in the other furnishes the shop with some immediate return for the expense of instruction.

Manual-training and Trade Schools

The fatal defect in manual-training and trade-school systems of education is, however, the lack of such schools, and in the nature of things it does not seem likely that they will soon be established at public expense nor that many will be established by private benefaction. As a financial venture they are not likely to appeal very forcibly to the investor; it seems that if such schools are established to any considerable extent in the immediate future, it will have to be done by the association of manufacturers who most feel the need of the output of such institutions. These associations will, however, have to feel the need of such schools and be convinced that they are absolutely necessary to their own well being before they go to the expense of establishing the first one; until they do this, the rest of us need not lose any sleep over the matter. So while we wait for this universal establishment of the ideal trade school, let me suggest that, as the final training of the boy must be done in the shop in any case, probably no better place will ever be found to train a machinist than the shop itself. By the shop I mean the modern, up-to-date manufacturing machine shop. What method shall be established for such training will be a question for each shop to settle according to its individual need, but the fundamental idea should be that the persistent improvement of the personnel of the plant, the rank and file, is entirely consistent with modern business methods and will have its legitimate effect upon both the quality and quantity of the output. With a proper attitude of mind on the part of the management, the solution of the problem is comparatively easy.

Modern Machine-molding Practice

The Machines and Methods Used in Producing Wheels for Agricultural Machinery in Large Quantities and at Low Cost

BY G. P. CAMPBELL*

The extensive use of machinery for molding in all parts of the world has demonstrated to everyone beyond all doubt the following facts:

Cost of Castings—A reduction in cost of castings, increase in output and the employment of cheaper labor.

Cost of Patterns—Reduction in cost of making new patterns and pattern repairs. A hasty consideration of this assertion might cause the reader who has footed some big bills for pattern work to doubt its practicability. As the proof of the pudding is in the eating, I shall endeavor to present the proof.

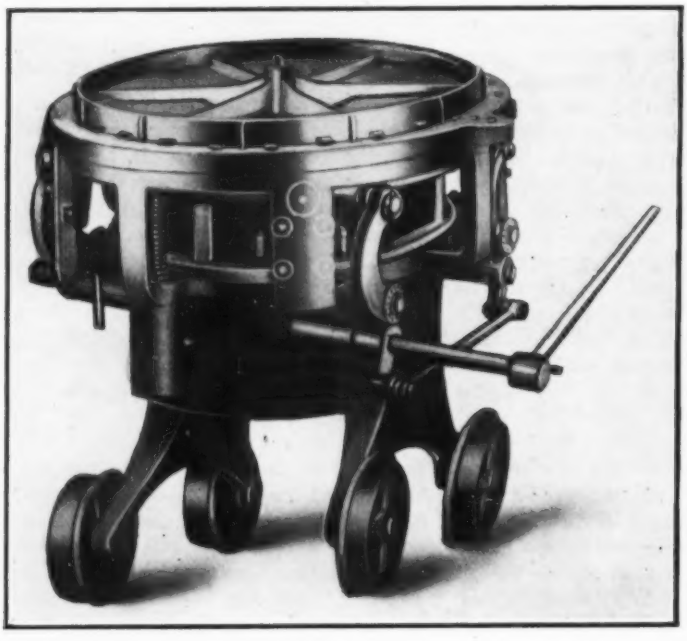


FIG. 1

FIG. 2

PORTABLE ROUND TWO-PART MACHINE

For bench or floor work for standard use, if wooden patterns are used, they must be constructed in the best manner possible, and of hard wood. In this case it means the pattern must be repaired at frequent intervals; it frequently loses its correct shape and form, from warping and swelling of the wood, and if in constant use must be replaced with a new pattern at regular intervals.

If metal patterns are used, they must have draw holes and rapping holes in them. I have seen the best of metal patterns rendered unfit for use by excessive rapping and rough handling; in many cases the men use the edge of some projecting part to strike the hammer against, and do not bother to use a peg or screw in the lift hole. There is useless labor in making a parting with a hand tool, and in many cases (such as loose rings for sheave wheels, for three-part flask work, since loose metal parts cannot be used, owing to the heavy weight) they will not lift with a cope. This, in some cases, will cause a drop in the mold, the projecting edges of sand not being sufficient to sustain the weight at that point.

In machine molding all these objectionable features are dispensed with. Each pattern, no matter how light, is screwed or fastened to the pattern plate, keeping it straight and in shape, even if of irregular form. The pattern plate of both nowel and cope conform, of course, to the required shape or form of pattern.

Gating—This is one of the fundamental features of machine molding and sometimes requires considerable experimenting before the desired results are obtained. The cutting of the gate or runners is not done by a piece of tin, or dug out regardless of size, shape or position, by the hand of the molder, each one different from the other. But once get the gating right and if you then get imperfect castings the fault lies elsewhere.

Whether 25 or 25,000 castings are made on the right kind of a molding machine, it will give you the last casting of the same shape, form, size and weight as the first. Other features that give superiority to the molding machine are: Duplicating a large number of pieces without frequent alteration of patterns to allow for useless rapping; the absence of any change in shape or form by reason of repairs to the pattern in the local foundry; saving time by not having the patterns continually returned for alterations to conform to the ways of every new man put on the work, putting on here and there for the molder who does not rap so much, again taking off for the next molder, who will drive his pattern ⅛ inch each way before lifting out of the sand.

When these changes in the patterns are made, the castings do not fit the tools and jigs; lugs and surfaces must be chipped and filed or the tools altered. Then comes another lot of castings still different, and more changes must be made.

Figuratively speaking, all molding machines are divided into four classes, namely, stationary, portable, power and hand machines.

A stationary machine saves only in the time consumed in making the molds.

The portable machine not only does the same work as the stationary, but can be moved close to where the flasks and sand lie. Thus it saves the time used by

*Copyright, 1907, by G. P. Campbell.

the workman in useless walking, carrying sand, flasks and heavy molds.

As a practical illustration of the difference between the stationary and portable machines, take a foundry making 300 flasks 12 inches wide, 10 inches deep and 28 inches long, for light hanger castings. Assume that these molds are put up either by hand or on a stationary molding machine located at the end of the shop or wing of the foundry. The space I refer to is 30 feet wide and 80 feet long. The flasks are in six rows, 50 in a row. From the bench or machine the nearest row is 5 feet, the farthest 75 feet distant. Taking one-half of these distances for an average gives 40 feet.

The molder puts up 300 copes and 300 nowels, a total of 600. As the molder must carry the flask to where it is placed on the floor and walk back again to his bench or the machine, he will travel twice 600 times 40, 48,000 feet, or 9 miles and 280 feet. Half of this distance he has carried the heavy flasks, to say nothing of rickety, splintery bottom boards.

Now consider the portable machine, similar to Figs. 1 and 2, rolling on tracks. The floor plan of the bay is six rows of flasks, 50 in a row. One track for each machine occupies the two middle rows. The cut-up sand occupies the next row on each side. The empty flasks are piled three high on the track of each machine; as they are used up, the machines are moved forward in the space the flasks had occupied.

When the time saved is figured out, it shows from 75 to 80 per cent. in favor of the portable machine; the operator's work is not so heavy, leaving him fresh for his other duties.

Power Machines

On some classes of work the power machine will give good results if competent men are employed. In this case the operator must be able to judge when his flask contains enough sand, also when it is sufficiently rammed.

The writer has seen a laborer who never saw the inside of a foundry 48 hours previous to his introduction to a power machine. To the astonishment of the entire shop the greenhorn didn't have room enough on the floor for the flasks he put up. Of course some were lost, but only a small percentage. This man seemed to grasp the idea of doing just what he was told to do. He seemed to find out how many shovels of sand were required to fill the flask.

In another instance one of the largest foundries in the West installed air-pressure machines which, while they did the work on some classes of castings, fell down completely on others, with the result that after two years of costly experimenting they were thrown out and hand-ramming machines substituted.

Hand-ramming Machines

This mode admits of a greater range of work than could be obtained on power machines and allows a wide range for portable work. The type of machine now to be considered is known as portable round double-shaft machine, stripping-plate system. All metal patterns and stripping-plate machines are mounted on wheels sufficiently rigid to permit of ramming the flasks; yet they are easy to move along on a cast-iron track sunk in the foundry floor. The machines shown in Figs. 1 and 2 are special machines, were made and used for these patterns only and are in constant use. During the busy season the machines are used for two shifts; 200 wheels are cast at each of two heats, making 400 wheels per day of 24 hours. I am informed that the repairs on these two machines for the last five years have not exceeded $40, and they are still used every day. Air hoists are used when pouring off and will be described later.

The Casting

The casting of the mowing-machine wheel is shown at Fig. 3. It has six arms, a gear cast in the center on one side and a hub on the other side. The wheel weighs 70 pounds and is 33 inches in diameter. The flask in which this wheel is made is shown at Fig. 4. It is used for these wheels only. Fig. 1 shows the cope machine, pattern up, while Fig. 2 shows the same machine with the pattern down; Fig. 3 is the casting; Fig. 4, flask; Fig. 5, molding-machine frame; Fig. 6, stripping plate and stools; Fig. 7, nowel machine, pattern up; Fig. 8, nowel machine, pattern down; Fig. 9, gear stool center; Fig. 10, filling in block for flasks; Fig. 11, mold ready for pouring on line *X Y*, showing arms; Fig. 12, mold ready for pouring on line *V W*, showing hub and rim.

Output

To reach the large output of these wheels per day, every point was carefully considered and all useless time and labor eliminated.

The flasks are made as light as possible, 3/16 inch thick. All ribs are located close to the pattern, to do away with useless ramming of sand. All parts of the pattern not stripped have plenty of draft. There is no sand between arm space *a* in the flask, Fig. 4.

The spaces *a a*, Figs. 4 and 6, are fitted with blocks of wood so no sand can get into these spaces. No bottom boards are used. Just enough bars are put in the flask to hold the sand without boards; no venting is required, except at the core. Before ramming up the cope, a vent wire is placed on top of the core print, but it is withdrawn before striking off.

The same letters of reference show corresponding parts in all the views. *A* is the molding-machine frame; *a*, space between arm in flask; *B*, yoke of molding machine; *C*, stripping plate; *D*, arm stools; *E*, gear stool center; *F* bottom part of arm stools; *G*, outside flange on rim, attached to stripping plate; *H*, pattern; *I*, arm of pattern; *J*, wheels; *K*, lower part of machine frame; *L*, gear part pattern; *M*, space for center piece; *N*, core print.

Cope and Nowel

The pattern for the cope half is shown in Fig. 1. This pattern is made of iron and in one piece, that is, the rim, arms and hub are cast in one piece with an outer flange at *H*, Fig. 7, to fasten to sliding yoke of the machine or draw plate *B*. The stools are also made in one piece, one for each space between the arms. The six are cast in one piece. After the stool pattern for the cope is finished, a plaster cast is taken of the angle at *D*, Fig. 7. A piece is first cut the same shape and size as the space between the arms, for stools *D*. Nails are driven in at an angle at the hub side of the stool *D* to hold plaster. A plaster cast is now taken of the angle at the hub side of the stool. After getting the correct shape, the leg and lower base are fastened and all six parts screwed together.

The bottom part of the stools at *F* is planed or milled to correct hight for both cope and nowel. These stools must be adjusted very correctly or they will leave a fin at *D*. The flange *G*, on the rim of the nowel pattern, is cast on the stripping plate at the inner edge of *C*. This plate is fastened to the frame of the molding machine *A* with flat-head machine screws.

The surface of the machine frame at *T* is turned up true in the lathe to locate stools *D* and *E*. These stools are also fastened to the yoke frame *B* with machine screws.

Mounting Patterns

The nowel halves of Figs. 7 and 8 are fitted up first. The stools, which have all been fitted, are laid on the bottom part of the machine frame *F*. This part of the machine is generally called the foundation plate, although not shown in Fig. 5, and it has been found to save much time and trouble to have this plate loose, so that the parts can be fitted on the bench and the whole then fastened in the frame *A*.

Great care should be taken in making the stool patterns for the cope and nowel. There should be very little fitting on these parts. It will be found advantageous to cast some little bridge pieces, shown at *d d*, Fig. 6, connecting all the stools at the top. Of course the bottom is all one piece, the center stool *E* being separate. The stool part *D* is laid on the surface *F*. Center stool *E* is now put in pattern *H* and the pattern placed on yoke *B*, with patterns up. The stripping plate is now put on, a clearance of 1/32 being allowed all over between the sliding parts of the stool, pattern and stripping plate. The

holes are now marked and each part removed, drilled, tapped, put back in place and finally screwed fast. The lugs for the pin holes for the flask are cast on the stripping plate at *c c*, Fig. 6, all on one piece.

The fitting of the nowel part is practically the same as for the cope. The core print on the nowel side *N* is attached to the pattern at the center and stripping on the stool *E*, the six parts of stool *D* all being cast in one piece. The pattern *H* is made with a flange, shown in Figs. 7 and 8, where the pattern rests on the yoke frame *B*. The flange is for screws for fastening to the yoke. *O*, Fig. 3, on section of arm, shows the parting at that point. This allows a solid bed for stripping the teeth for gears on one side. Sections of arm and rim of casting are shown in Fig. 3. In Figs. 7 and 8, wheels are shown at *J* attached to frame *A*. They run on the tracks sunk in the foundry floor.

Fig. 10 shows 12 pieces of wood *C* for half-part flasks. Fig. 11 shows a view of the mold ready for pouring in section on line *X Y*, Fig. 3 showing the arms of the wheel, hub and core in position. Fig. 12 shows another view of the mold ready for pouring, which shows more clearly the construction of the flask, with the rim of the wheel, hub and core in position. Air hoists are used in pouring off and run on two trolleys direct from the cupola. The flasks lie on the tracks on which the machines run.

Molding

In starting to mold, two men operate each machine—one man raises the pattern by throwing to the right the lever shown in Fig. 1.

The flasks are piled on the rack in front of the machine; one is now taken

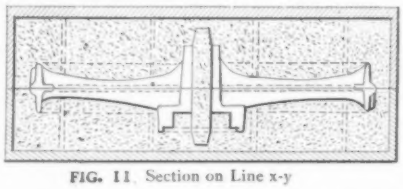


FIG. 11. Section on Line x-y

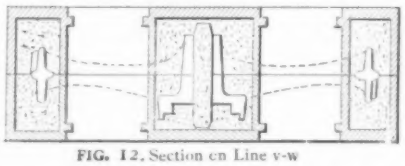


FIG. 12. Section on Line v-w

MOLD READY FOR POURING

and put on each machine, and parting sand first thrown on. The blocks *c*, Fig. 10, are now laid in spaces *a* shown in the flask, Fig. 4. Sand is riddled over all open spaces, sand shoveled in and all rammed. A vent wire is placed on the core print on the cope only. This is withdrawn before striking off the sand on top of the flask. The lever is now thrown over and down, withdrawing the pattern, as shown in Figs. 2 and 8, through the stripping plate *c* and tools *D* and *E*.

The nowel is placed on the floor on the rack in front of the machine; the cope is lifted off the other machine, the core placed in and the mold closed. The machines are now moved forward close to the next flask. The sand, all cut, lies in a row between the two machines and the racks on each side. The trolleys are directly over each track.

Molds are not finished in any way, not even blacked; but it is seldom that a casting is lost. The castings are reasonably smooth for their purpose. The only finishing done on the wheel is to face off one side hub and bore out the hole in the hub.

Experiments recently made at the National Physical Laboratory bring out a new and valuable fact—namely, that wind pressure is not the same on large surfaces as on small experimental models. If, for example, a given wind velocity is brought to bear on a square foot of surface it will be 18 per cent. less per square foot than if it were directed on 100 square feet of surface. It was demonstrated, too, that this relation is constant for flat forms, however complicated. A builder or engineer who knows that a structure may be exposed to a wind of 80 miles per hour and that the pressure per square foot as determined by model is, say, *x* pounds, should allow for his larger construction 20 per cent. extra. The reason for this seems to be the more thoroughly reduced pressure on the lee side of a larger area. —*The Engineer.*

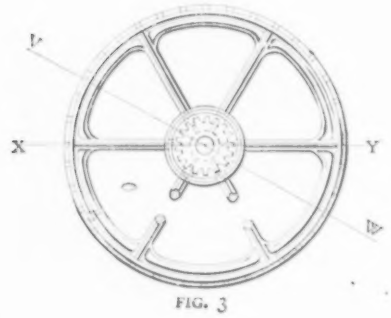


FIG. 3

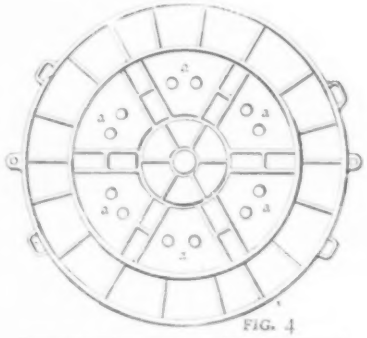


FIG. 4

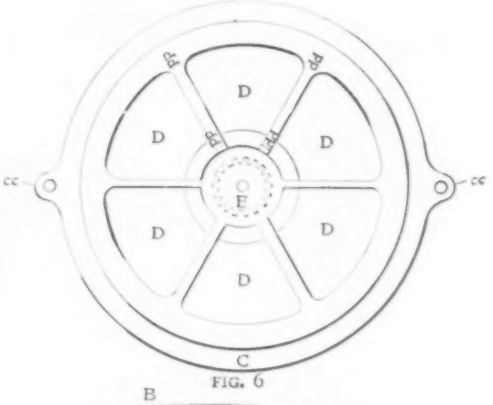
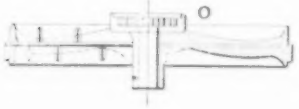


FIG. 6



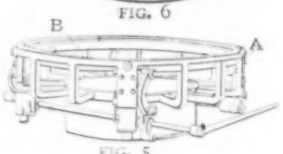


FIG. 5

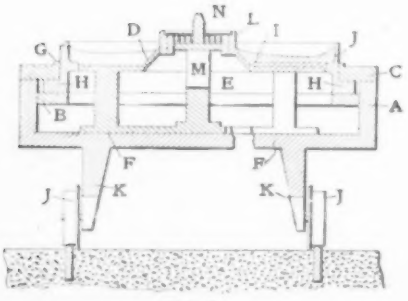


FIG. 7

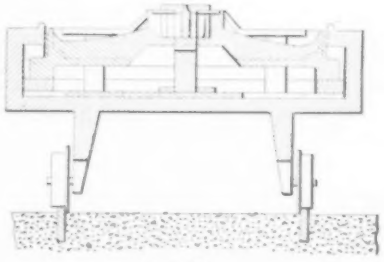


FIG. 8

FIG. 9

FIG. 10

MAKING MOWING-MACHINE WHEELS

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Adjustable Angle Plates

While visiting a small factory lately, I came across a couple of interesting devices. The first of these I saw in the experimental room. It was of the homespun variety, but the marks of wear and tear which it carried showed quite plainly that it was used considerably.

It went by the name of the "elevator." Fig. 1 herewith shows its plan and side

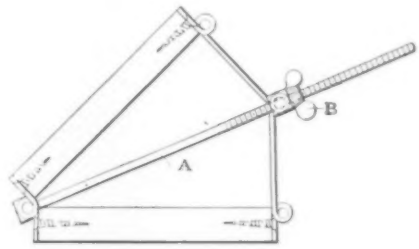


FIG. 1. SIMPLE, ADJUSTABLE ANGLE PLATE

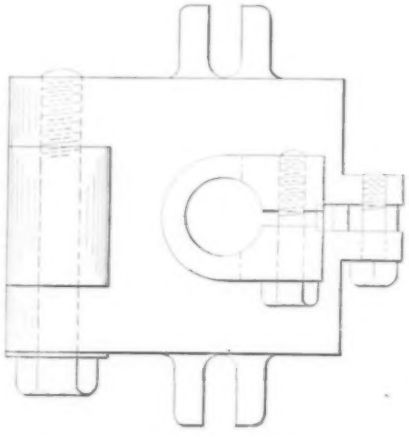


FIG. 2. PLAN VIEW OF ADJUSTABLE ANGLE PLATE

elevation. It consisted of a couple of pieces of beech about 7x6x1 inch nicely planed and squared. Some hinges of cold-rolled stock served to connect the two. The hinge pins were made from iron ⅝ inch square, the one at the front extending the full width of the boards, the one at the back extending only half the width, as shown. Riveted into the front hinge-pin was a rod *A* whose outer end was threaded about 6 inches and was furnished with a wing nut *B*. When any holes were required to be drilled in an article at an angle, it was put upon the

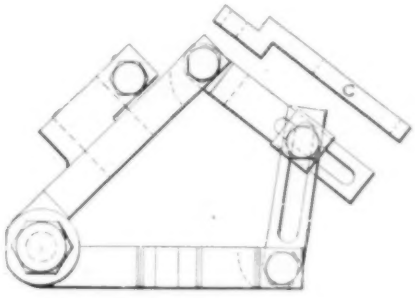


FIG. 3. SIDE VIEW OF PLATE OPEN

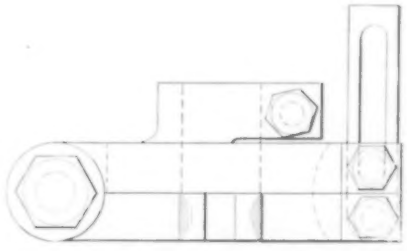


FIG. 4. SIDE VIEW OF PLATES CLOSED

"elevator," which was adjusted to the required angle by means of the wing nut. The range of the device was from zero to 45 degrees. It seemed to me to be a useful tool, substantial, but cheap, and one that could be easily made.

Figs. 2, 3 and 4 show another kind of "elevator" or adjustable angle plate. This was designed in the tool room for work on punches. It was made of gray iron and machined all over. It was used on the lathe, shaper, planer, miller and drill press, in fact, anywhere.

Fig. 2 is the plan of the fixture when in the closed position. Fig. 3 is a side elevation showing it open at an angle of 45 degrees. The slotted pieces at the back were of mild steel, machined all over. Fig. 4 is a side elevation when closed; one only of the back links is shown in position. With this link only the fixture is capable of adjustment to about 25 degrees; any adjustment greater than this needs the link *C* to be used as well.

The bottom plates are furnished with slotted ears for fixing, and the top plate is furnished with a heavy boss bored out to suit the power-press punch-shanks. These in their turn are furnished with bushes to suit smaller shanks and also to accommodate the hand-press punches. This is a very useful tool where much press-punch work has to be done.

England. WILFRED GEORGE.

Recessing Tool Slide for the Turret Lathe

Referring to the article at page 305, we note the particulars given of a cross slide and recessing tool for the turret lathe. In this connection we send you photographs showing two similar tools which have been marketed by us for many years.

FIG. 1. RECESSING TOOL SLIDE FOR NOS. 3 AND 4 HERBERT LATHES

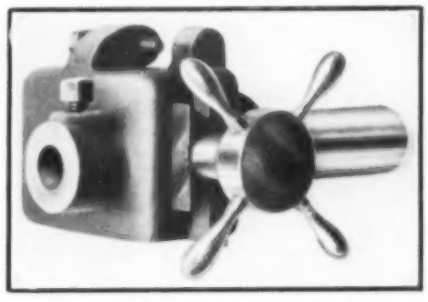


FIG. 2. RECESSING TOOL SLIDE FOR NOS. 5, 6 AND 7 LATHES

We consider that the construction of the slide in the case of the larger of the two tools is much better than that shown by your correspondent, as in the case he illustrates the downward pressure of the tool tends to spring the slide away from its holder, the slide pivoting on its bottom edge, whereas in the con-

struction we have adopted, the arrangement of the slides is reversed and the slide tends to swing around the top corner, the pressure of the tool thus tending to keep the two slides in close contact rather than to pull them apart.

In the case of the smaller tool, the three holes which are shown for cutters are for the purpose of enabling the tool to deal with a wide range of diameters.

ALFRED HERBERT, LTD.,
Coventry, England.

A Gas-heated Soldering Iron

The iron to be described is for manufacturing purposes where the work is brought to the operator. Fig. 1 shows the assembled iron, which consists of the copper-iron proper *A*, a machine-steel shank *C*, the cast-iron adapter *B* and a gas-pipe handle. This iron is heated on the Bunsen burner principle, and you can retain any desired heat in the iron by regulating the supply of gas and air, which is supplied through the ⅛-inch gas-pipe handle. Fig. 2 is a detail of the machine-steel shank; Fig. 3 is a detail of the copper.

The gas-pipe handle should be made about 10 inches long and have a wooden handle on the outside, leaving the pipe extending from the back long enough to connect the rubber supply tube. The rubber tube is connected to the air and gas supply. The air should be delivered at about 1 pound pressure. Air and gas

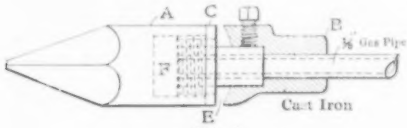


FIG. 1

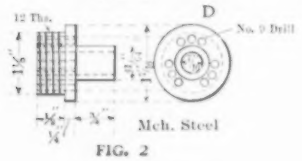


FIG. 2

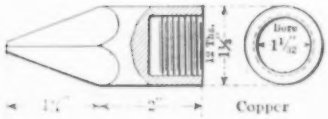


FIG. 3

GAS-HEATED SOLDERING IRON

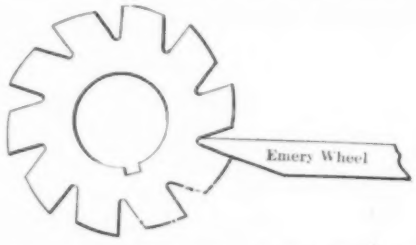
should each have a cut-off valve or cock, such as a common gas cock.

To light, turn on the gas and light at point *E*, Fig. 1, and then turn on the desired amount of air to produce the blue flame. The gas and air enter chamber *E*, escape through holes *D* of the machine-steel shank and burn between the shank and the cast-iron adapter. For rapid soldering there is nothing to equal this style of iron.

Grand Rapids, Mich. F. C. MASON.

Using the Beveled Side of the Wheel in Grinding Cutters

I have noticed at various times articles about grinding formed cutters, but they all say to use the flat side of the wheel. If the reader will true the beveled side of the wheel so as to make it perfectly straight and then adjust his machine so as to bring this beveled side radial with the center of the cutter, he will not be half so



USING THE BEVELED SIDE OF THE WHEEL IN GRINDING CUTTERS

liable to draw the temper of the teeth and will get his cutter ground in less than half the time taken if the flat side of the wheel has been used. The sketch will explain itself.

I have ground cutters in this way for years, but have never seen it done in other shops. All the books I have seen on the subject say to use the flat side of the wheel, which, to my notion, is about the worst possible way. The wheel soon becomes glazed and heats the edges of the cutter very quickly, leaving the extreme cutting edge so soft that it will make only a few cuts before it needs grinding again. I have seen large formed cutters that were made by some of the leading makers, which before being used were found soft on the edges, no doubt due to heating in grinding, as, after being reground the other way, they would do about six to eight times the amount of work before needing grinding again.

St. Paul, Minn. J. E. RAMOPON.

Does Steel Expand or Contract in Hardening?

With reference to the statement by Mr. Madigan, on page 859, Vol. 30, Part 1, on the distortion of steel in hardening, and commented on by W. L. Hardy, on page 423, I should like to state that carbon steel does expand and contract. You cannot harden it without some change.

Take a die and cool it out edgeways slowly. You will find that it expands, whatever shape it may be. Harden the same die or another quickly, face downward, and you will find that it contracts. It matters not whether the tool is solid or otherwise, it depends on the way it is cooled; if sharply, the water closes on the tool quickly, thereby compressing the carbon into smaller space, causing contraction. Now by cooling out slowly, the water gets the chill off before the tool is fully emerged, allowing the carbon to distribute itself in a more even manner and causing expansion. I have made a few experiments and found it always the same.

The experiment that I tried which might be useful to some of the readers is to take a bucket of water and dissolve some lime in it; by hardening in it, all your tools will expand.

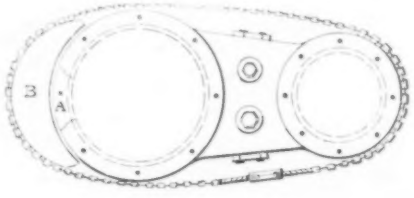
London, Eng. D. G. JACKSON.

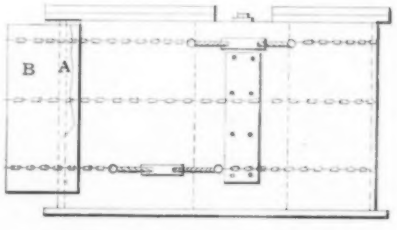
Repairing a Broken Cylinder at Sea

We read a lot about makeshift repairs at sea these days, but the following beats most of them:

The system of draft for the boiler fires was the "Ellis & Eaves induced," consisting of a 50 horse-power compound engine and 10-foot fan placed at the base of the smokestack right on top of the boiler casing.

In the summer time the climate around those fan engines was anything but cool and exhilarating, the temperature often being 140 degrees Fahrenheit in the shade, with the result that the oilers made their periodical visits to the engines as brief as possible. One morning about two days out from port, the visits were so curtailed that the white metal in the crank-pin box, of the low-pressure engine ran out, and the cylinder head and all the studs went skyward. The piston rod took the form of an S, and a piece about 10 inches long and 3 inches broad was broken





REPAIRING A BROKEN CYLINDER AT SEA

clean out of the cylinder wall. There being no spare cylinder, the old one was patched to the accompaniment of sweet blessings on the man who caused the trouble.

The studs were drilled out of the cylinder and new ones fitted in. The piston rod was heated, straightened and filed true. The piece of cylinder wall *A* was put in place and a hardwood block *B* was hollowed out to fit around the cylinder so as to keep the broken piece in place.

Around the block and cylinders three chains were wound and tightened up with turnbuckles. White metal was then poured between the block and the cylinder wall. A spare cylinder head was fitted. The crank-pin boxes were rebabbitted and fitted up, piston clearance taken and the piston rod re-packed, with the result that the engine ran satisfactorily for three weeks till a home port was reached.

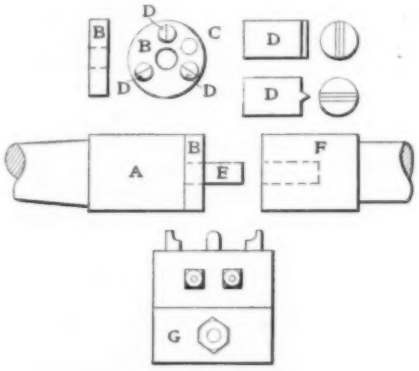
Brooklyn, N. Y. JOHN BREMNER.

Turning Rollers

Having to make a large number of machine-steel rollers, 1 21/64 inches diameter by 3/16 inch thick, with a ⅜-inch reamed hole, I tried to find a quicker way to turn them to size than putting them on an arbor between the centers of the lathe.

After sawing the disks off in a cold saw, I chucked them in the lathe, drilled and reamed them, using a turret head on the tail spindle. Then I made a center *A* for the lathe, with a ⅜-inch pilot *E* a sliding fit for the hole in the rollers.

The disk *B*, about ¼ inch thick, holds the three drivers *D* and the pin *C*, which are of 3/16-inch drill rod, filed to a chisel point and hardened. The drivers project from *B* about 1/32 inch. The tool holder *G* is bolted on in place of the tool post and carries three tools of ¼-inch square Novo steel. The outside tools round the corners and the center one turns the rollers to size. The piece *F* revolves and has a ball-thrust bearing fitting the tail spindle. A lever on the tail spindle forces it against the side of the roller, holds the roller against the drivers *D*, and it revolves with the work.



TURNING ROLLERS

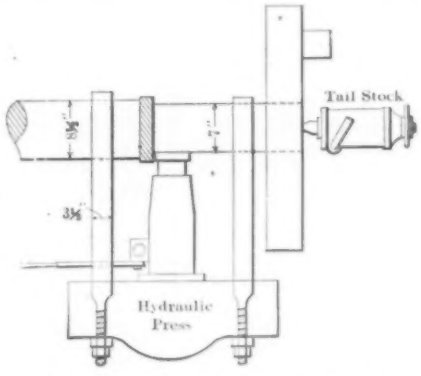
In operating, the lathe is run at its fastest speed, about 600 revolutions per minute, and is not stopped to put in or take out the rollers. The operator picks up a roller with the right hand and places it on the pilot *E*, then grasps the tail-spindle lever, pulls it toward him and holds the roller firmly against the drivers *D*, while he runs the carriage back and forth with the left hand.

We have turned as high as 100 in 30 minutes with this device, which I think makes them nearly as cheaply as we could make them on an automatic screw machine. I was a little doubtful about the drivers *D* doing as much as I required of them, but find there is no slippage whatever.

Kalamazoo, Mich. J. SPART.

Straightening an Armature Shaft

I had a direct-connected armature shaft which was sprung 5/16 inch in one bearing close to the spiral gear. It was a case of straighten or make a new shaft. To make a new one was rather expensive, as



STRAIGHTENING AN ARMATURE SHAFT

there were two steel disks, two spiral gears (which were shrunk on) and an armature to remove. Therefore I decided to straighten it.

To do this I hung it on the lathe centers and then laid a piece of sheet iron across the lathe bed, on which I built fire-brick up to and around the shaft, thus forming an arch to hold the coke.

I then put a blowpipe of air and gas through the side of the arch and directly under the shaft, turning it occasionally to get an even heat. When red hot I attached a 100-ton hydraulic press by blocking up even with the centers and using two U-bolts around the shaft with a clamp on each across the back end of the press, as shown.

I then put 80 tons pressure on it, and upon releasing this so as to revolve it, I found it was still 1/16 inch out of true.

After repeating the operation twice with less pressure, my shaft ran true. I then allowed the shaft to revolve in the lathe until cold, and after filing, polishing and pinning the spiral gear which was loosened by heating, I placed it in the engine. It is now running and giving us no trouble.

Belmont, N. Y. A. E. FLUENT.

Some Uses for Fiber

At page 575 a correspondent writes of using fiber for thrust disks, which in my experience is just the thing to be used under the conditions cited. Some of the uses I find for it are as follows:

In centering finished work in the speed lathe, supporting the end being centered in a three-jaw center rest, the best material for the jaws is fiber, as it will not rough the surface of the work.

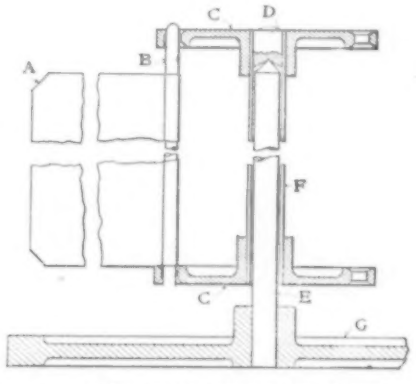
In the old-style grinders with revolving headstock spindle, a fiber washer is always used for taking the end thrust. These washers are 1½ inches diameter, 1-inch hole and the shaft runs at 500 revolutions per minute. These washers would glaze over and become dead smooth after a few weeks' run and would outwear every metal that was tried.

Fiber is good material for grinding rests, being easily formed to shape and having great wearing qualities when so used.

Lowell, Mass. PAUL W. ABBOTT.

A Rack for Displaying Blue Prints

Some years ago the writer was connected with the engineering department of a firm manufacturing a line of high-speed automatic-feed rotary printing presses. These presses worked on stock varying from French tissue to flour sacks. From the nature of the work most orders called for one or more attachments, as for numbering, perforating, etc., which were gear driven from the press. This, of course, resulted in the use of a large number of gear patterns and drawings. At the time of my taking charge, the number of these had reached a point at which it was thought desirable to take stock and see if occasionally an existing drawing or pattern could not be made to serve instead of getting out a new one. The drawings on hand included gears usable for almost any desired combination of intermediates,



A RACK FOR DISPLAYING BLUE PRINTS

ranging in pitch from 24 to 3, and in diameters from ½ inch to 16 or 18 inches.

In order to keep track of this stock, the poster shown in the accompanying illustration was made and placed at a point convenient to the designers. One of 20 leaves is indicated by *A* and was made of No. 26-gage sheet steel, formed around a spindle *B*, soldered thereto and japanned. The castings *C*, pressed on the tube *F*, are far enough apart to allow *A*

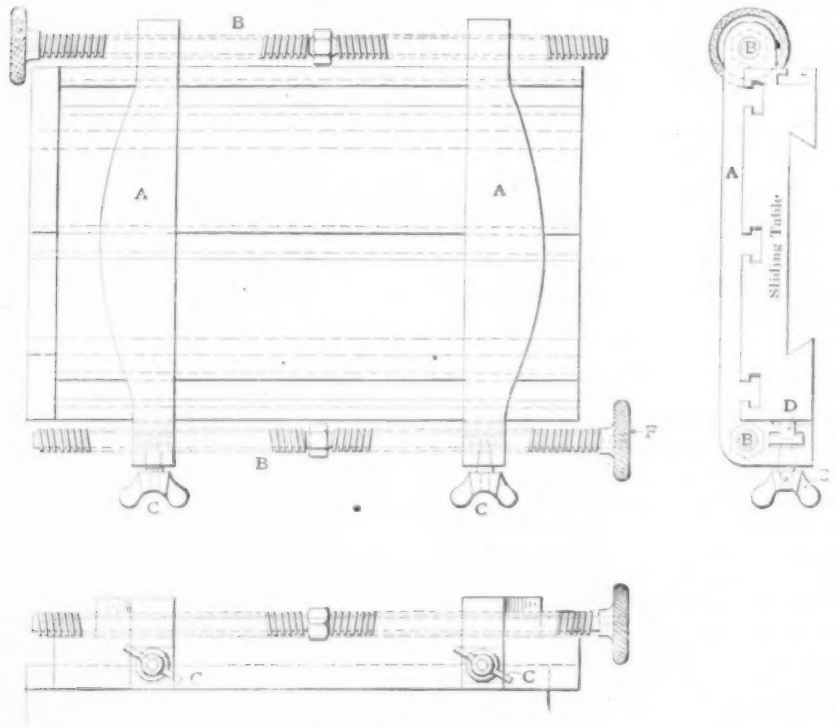
to be lifted out. A case-hardened machine-steel plug *D* is pressed into the top of *F*. The internal diameter of *F* is enough greater than *E* to allow the whole system to revolve on the pointed upper end of the cold-rolled steel spindle *E*, which is also case-hardened. The holes in *C* for the spindle *B* are large enough to allow it to be swung aside and dropped out of or into place. The spindle *E* is pressed into *G*, which, in our case, was a 12-inch gear blank. On the leaves *A* were pasted blue prints giving all needed data for the many gears. It proved an extremely serviceable and convenient device, and avoided much needless duplication of drawings.

Detroit, Mich. ROBT. G. PILKINGTON.

A Special Vise for Die Grinding

We had in our shops a Garvin No. 3 universal cutter and tool grinder, that could also be used for surface grinding. Our die-making department was kept busy all the time with an extremely wide range of work, and we had very often to grind punches and dies of small and medium size. The vises found on the market seemed too clumsy, compared with the lightness of the grinder, had very narrow openings between the jaws, which were too deep, some of our dies being only ½ inch thick.

We made a special vise, as shown in the accompanying drawing. *AA* are the two jaws, fitting and running in the three T-grooves of the sliding table. They can be easily fixed in any position by means of the two clamping arrangements obtained by forcing the two pieces *DD* against the side of the sliding table with the two screws *CC*. The adjustment of the jaws is made by turning the two right- and left-hand screws *BB*, simultaneously. These were only 7-16 inch diameter, and the jaws were only ⅜ inch above the surface of the sliding table. The whole arrangement was light and strong, and allowed the grinding of the longest punches we used in our machines. This vise proved extremely useful for such kinds of work, as besides the easiness with which the work was set in place, it had also the advantage of allowing the grinding of die plates almost as large as the sliding table, while the vertical adjustment of the machine was entirely available for the work. The two knobs *FF*, fitting on the square end of the adjusting screws, were removable; removing one of them and loosening the two clamping screws *CC*, the vise was easily taken off and the surface of the table free for the setting of the various attachments for the grinding of milling cutters, reamers, etc. We were so satisfied with this simple device that we made another vise, quite similar in construction, for a small vertical milling machine. In this instance also, it proved very useful for small work.

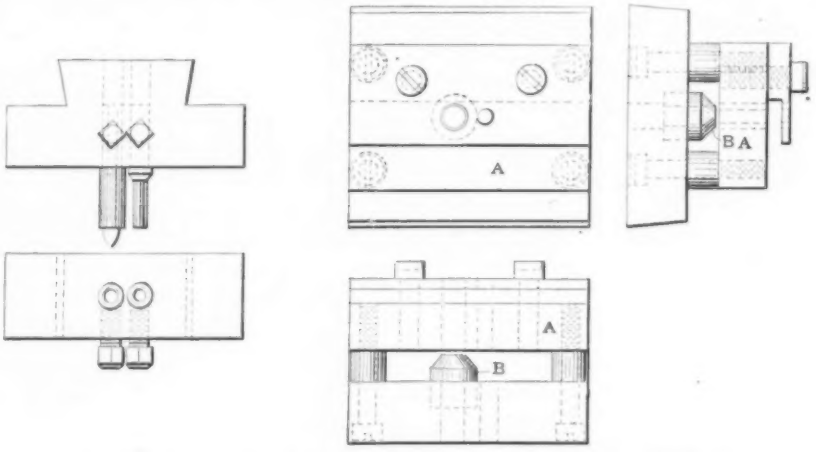


A SPECIAL VISE FOR DIE GRINDING

New York, N. Y. G. SACERDOTE.

Combination Punching and Trimming Die for Fiber Washers

The illustration shows a combination punching and trimming die for fiber insulating washers for small electric motors and instruments. Formerly they were punched with an ordinary follow die and then trimmed one at a time in another die. But having thousands of them to make, and the old way being very slow, I designed the one shown in the sketch.



COMBINATION PUNCHING AND TRIMMING DIE FOR FIBER BUSHINGS

The punch is made the same as any follow punch, with the exception of the punches being made a little longer than usual. The upper part of the die *A* is made in the usual way, only that the large hole is made about 0.025 larger than the finished washer is to be and with no clearance. Directly underneath and in line with the hole in the top die is placed another die *B*, which trims the washer when forced down by the punch. The lower die is placed just far enough away from the bottom of the upper die to allow the trimmings to escape. This lower die is made conical at the top and comes very near to a sharp edge at the hole, giving it a shearing cut.

The washers are punched from fiber ⅛ inch thick, and unless trimmed are very rough and irregular on the outside. But with a die made in this way they come out true to size and very smooth all around, and can be made in less than half the time. In setting the punch I allow it to enter the upper die far enough to just start the washer into the die underneath. The pilot on the punch keeps it in line so it will trim the washer true with the hole.

Concord, N. H. W. S. MACK.

A Gage for Interchangeable Work

The first order for the slide *A*, Fig. 1, was 1000, which was too small an order to warrant the making of any special tools or expensive gages, although the rib had to be exactly in the center and parallel with the edges of the slide. A very simple gaging device was arranged by merely milling a dovetailed slot on one side of a parallel block to fit the model *A;* then with a micrometer clamped on to a square, as shown in Fig. 2, both sides of the rib could be gaged for parallelism while in the block, from a surface plate. The second order was an unlimited one calling for at least 1000 pieces a day, so a special gage was made as shown in *B*, Fig. 1.

This gaging device has a nurled handle *c* with a tapped hole in one end to fit the threaded shank of clamp *d*, which shank also fits the lapped hole in the hardened block *e*. In the other end of the screw clamp is drilled a hole to match the hole in the block *e* for the pin *f* and the coiled spring. Pin *f* is driven into place in the block *e;* the spring between the block and the clamp releases the latter from the work when the nurled handle is unscrewed. A plate *g* is attached at one end of the block *e* with two screws and two dowel pins. The block and the plate are made of machinery steel, case-hardened and lapped on the gaging surfaces. When gaging, the piece *A* is placed in the gage against the stop *h* and the handle *c* is screwed up until the clamp is seated. A hardened and lapped snap gage *i* is used, one opening in the snap gage fitting the plate *g* and the other or narrower opening fitting the rib on the piece *A*. By reversing the piece in the gage it can be easily seen if the rib is central or not. The small snap gage is also used for gaging the rib while milling.

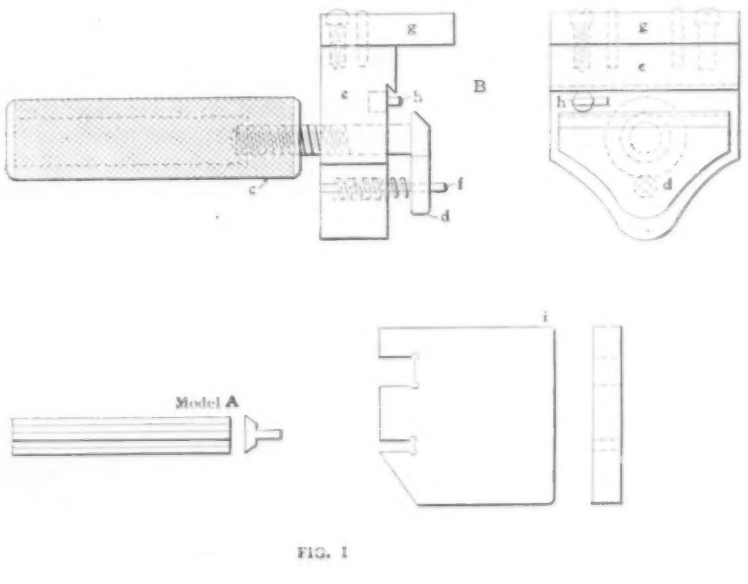


FIG. 1

The micrometer and square clamped together has also been found very handy for other work. By using a 3- or 4-inch micrometer clamped on a large square, a certain hight may be obtained from a center, or from one step to another, on a bench, lathe or milling-machine job; in fact, the arrangement is handy for gaging almost anything from a flat surface plate, especially where a micrometer surface gage is not obtainable.

New Haven, Conn. R. A. ALMOND.

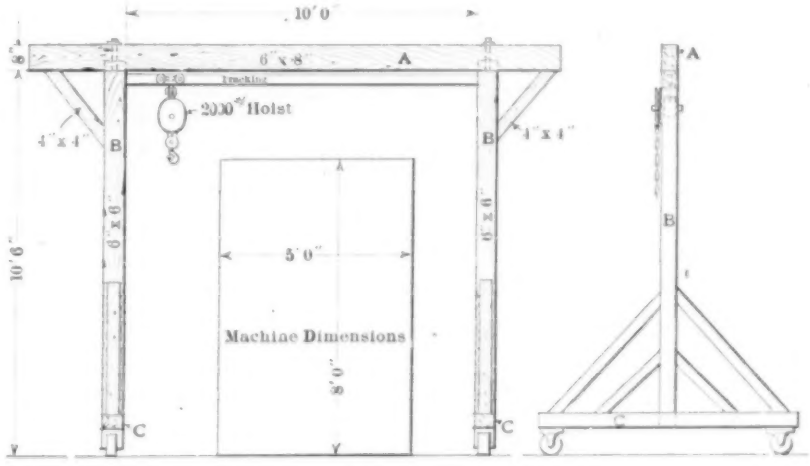
An Erecting Frame

Those erecting mechanics who have been out on large jobs of erecting where crane facilities are unknown will appreciate the traveling erecting frame shown herewith.

We had a cardboard machine to erect which was 48 feet long; the greatest width was 5 feet and hight 8 feet, and the heaviest single piece 2000 pounds. While erecting the last machine we used a regular tram rail attached to the ceiling over the center of the machine. We were compelled on the second machine, to devise other means of handling the parts, owing to the fact that we were unable to fasten tracking to the ceiling. Even if such had been possible, it would not have made a flexible enough apparatus.

The illustration will show fully the idea. In our case we had on hand a piece of pressed-steel tracking and trolley to suit it. These we attached to the cross-beam *A*. The uprights *B* were 6x6-inch yellow pine sticks mortised into the beam *A* and bottom sills *C*. Upon the bottom of the sills *C* and at each end we fastened regular-stock 6-inch rollers in frame. These we obtained at a hardware store.

The whole frame was braced as shown and made so it could be knocked down and shipped to another job. When the hoist was hung to the trolley, we were able to pick up a piece at either end or side of the machine and roll frame and load to the exact spot required. We estimated that we saved fully 15 per cent. in erection due to the expenditure of perhaps $20 on the frame, no account being



AN ERECTING FRAME

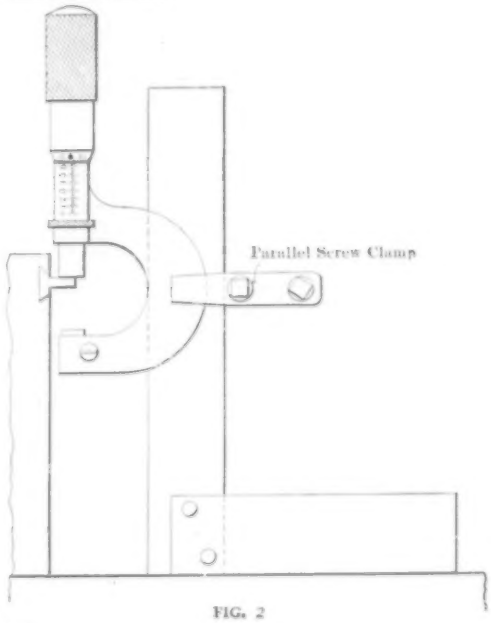


FIG. 2

A GAGE FOR INTERCHANGEABLE WORK

taken of the assured safety, to workmen, over other dangerous hoisting.

This apparatus has a wide sphere of adaptibility, can be made to suit almost any condition and is very low in cost considering its great time-saving features.

Philadelphia, Penn. SAMUEL P. YEO.

Producing a Difficult Piece Cheaply

I once had to devise a cheap method of machining several thousand of the pieces shown in Fig. 1. As machinery steel would be amply hard, I decided to use 3/16-inch cold-rolled stock. Material of the right thickness could be obtained from stock, but unfortunately not of the right width; however, as the nearest standard size was only ⅛ inch wider, it did not cost much to clamp the strips in bunches in the milling-machine vise and take a single cut across. Next the pieces were cut off to size and shape. This was done with a metal slitting saw in the miller, the strips being put in the vise, pushed up to a stop, clamped and cut off in lengths that would make two, allowing for a parting saw cut and finishing. They were then mounted in the jig, shown in Fig. 2, which held 60 at a time, held them top and bottom as well as clamping sideways, and also tilted the pieces 15 degrees. The saw was set once for all at the right distance from the jig, and the pieces were cut off, producing 120 of the right shape each pass. The jig was then turned on its side, the pieces rejigged and a light finishing cut taken over, which brought them exactly to size.

They were now ready for the two rectangular holes, which looked like a difficult operation on account of the extremely narrow strip between them, only 3/64 inch. These holes were punched by the punch and die shown in Fig. 3. In the die the spaces where the pieces were fed in were made a close fit so as to prevent any distortion taking place during punching. In operation a blank piece was pushed in the slot on the right and the 17/64x19/32-inch hole punched. This expanded the piece fairly tight in the die, necessitating an automatic knock-out device at the back. The operator would next push the half-finished piece in the slot on the left and another blank on the right-hand slot. The next operation of the press would cause the supporting punch *X* to first enter the hole already punched. As it was forced lower than the others by the spring *Y*, it was long enough to project through this hole and anchor in an angular recess below; that

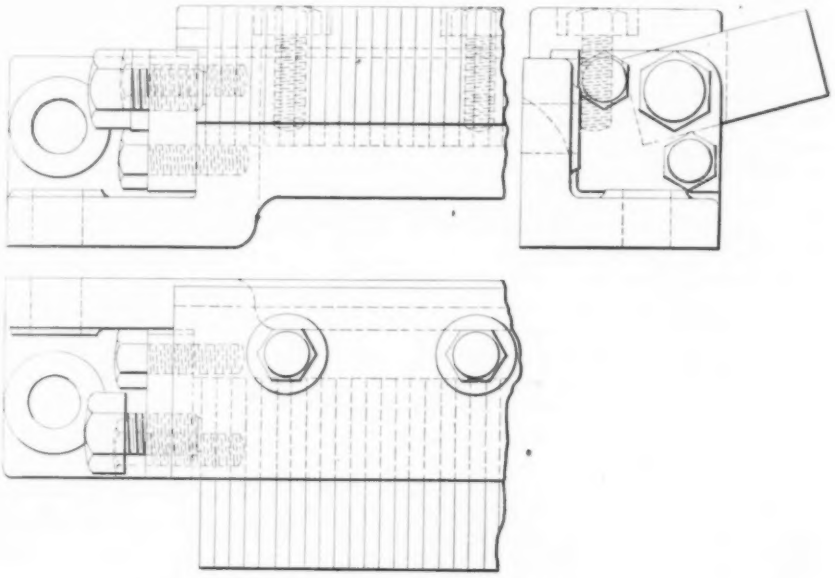
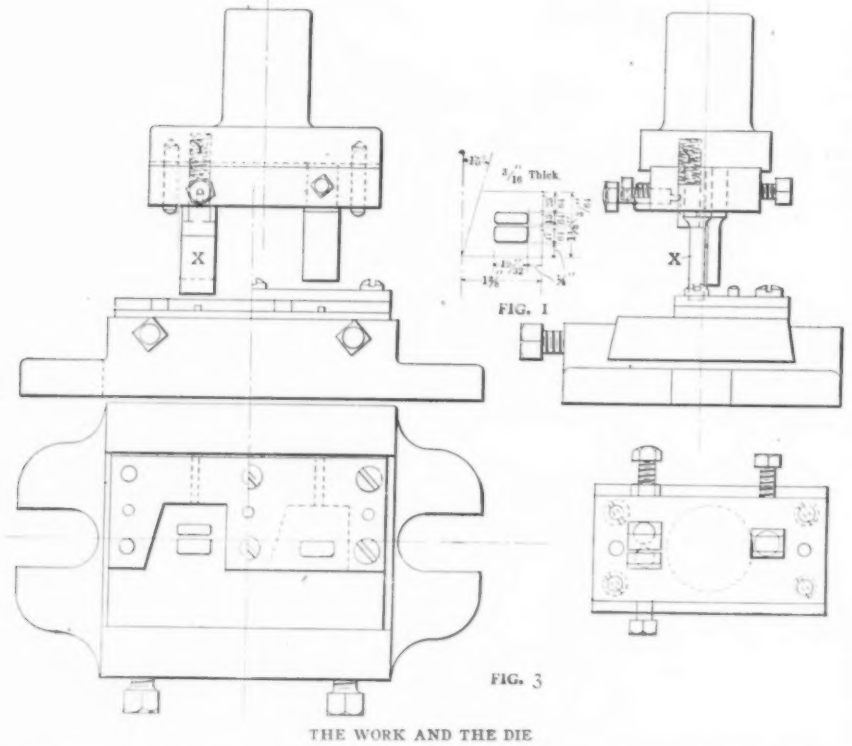


FIG. 2. THE MILLING JIG



THE WORK AND THE DIE

the other two punches could simultaneously punch the two holes, one in each piece. As the hole already punched in the first piece was filled by the supporting punch, this prevented the narrow bridge from being broken. On the up stroke both pieces would be pushed out and the operation repeated; thus a finished piece was produced every stroke. No more work was done on these; they were remarkably accurate and satisfactory in every way. The only part that did not have as nice a finish as might be desired was the sides of the holes, which had the usual punched appearance; but as they were to size, it was not of any practical disadvantage.

Buffalo, N. Y. GEO. P. PEARCE.

Refiguring Blue Prints

We have a great many blue prints to refigure—sometimes only one or two dimensions on a blue print, at others there may be a hundred changes on a set of plans. As it would take probably a week to make a new set of tracings, and while a set of prints can be refigured in a few hours at the outside and will answer every purpose for a single job, it is very desirable to have some satisfactory method for doing this.

We have tried all kinds of schemes: Red and yellow crayons, Chinese white and various potash combinations; but all have had some disadvantage. We

finally hit upon using white labels; after a little experimenting we ordered an assortment of white stickers, with gummed backs, which have proved very satisfactory. These stickers can be obtained of any size or shape. We have managed very nicely with three sizes. The smallest is round, 5/16 inch in diameter, for single figures. For feet and inches we have a sticker 5/8x1/4 inch and another 1x1/4 inch for longer blanks. These stickers cost 15, 20 and 25 cents per thousand, according to size, and are furnished by the Denison company.

Instead of these stickers being a disfigurement, we consider them an advantage, as they "catch the eye" and indicate at a glance just what dimensions have been changed.

Springfield, Vt. ROLYAT.

[The stickers certainly stick, and call attention to the changes by being decidedly different from the rest of the print.—EDITOR.]

Boring Holes in Jigs and Similar Work without Laying Them Out

The method described by Fred H. Sander, at page 634, of locating and boring holes in jigs, etc., on the milling machine, using the hight gage for measuring from the platen and other auxiliary faces, is hardly accurate in the sense that, when we speak of one inch, we mean an inch and not one or two thousandths over or under. It is possible under this method to come pretty close and, if corrections are made while boring, to obtain perfect results; but it has then no advantages over the old-time button method, accuracy and, at the same time, reasonable quickness in doing the work being required. There are several factors which, combined, make the method unreliable.

Some years ago I had charge of a tool room where the tool-inspection department, which was entirely independent of the tool room, required a limit of accuracy in the location of drill bushings of 0.0001 inch. After receiving a drawing for a jig, it was invariably my custom to complete this drawing by supplementing dimensions not furnished by the draftsman, that is, a drawing would show dimensions to centers of holes from a certain line, point or base; sometimes all holes would be located from these same points, sometimes not. In either case I calculated all distances from center to center of all holes, irrespective of their location. These dimensions were added on the drawing in ink and were used to check up by, the toolmaker measuring over plugs while the jig was being drilled.

Now to begin: Not all, in fact very few, jigs for irregular-shaped work can be laid off from a side or a face, and so our platen or angle iron would be useless; but granted for argument's sake that we have a jig to make in which these conditions are present, let us see what really happens.

In all my years of experience I never saw a milling machine, planer, boring mill or other machine tool the table or platen of which had a top or face prepared like a true surface plate. If any machine were finished in this way, I would call the man who did it a fit companion for the perpetual-motion crank, for the simple reason that after single job was done on this machine, in the setting up of which bolts and clamps were used to hold the job on the table, this table or platen would have lost its true and perfect face; and surely no toolmaker would undertake to true-up and scrape-in any table or platen after each job. Yet a perfect surface plate is the only surface on which a hight gage can be used if perfect accuracy is required. But it is a commercial and not a mechanical impossibility to build an absolutely correct machine. Errors will appear both in the platen and on raising or lowering the knee or moving the cross slide, also in tightening or loosening the clamps on the various slides.

We will assume that we have a milling machine in first-class condition, new or practically so, the platen supposedly and, as far as we can tell, good and true; we also have an angle iron, with lengths of sides say 6 and 12 inches long, which shows true under test with a good try square.

Now let us make the following test: Clamp the angle on the platen with the long leg up, attach the test indicator to the spindle of the machine, bring the indicator in contact with the angle iron at the top and raise the knee slowly, observing the reading of the indicator and at every inch tighten and loosen the knee-slide clamps. The result will surprise you.

Now proceed as follows: Take a good, hardened 24-inch square, which is known to be correct, clamp its heavy arm to the angle iron, the blade hanging over, parallel with the platen, at top of the angle iron. Bring the indicator in contact with the blade of the square on top and move the platen forward and backward, stopping and clamping from distance to distance, and observe the reading of the indicator. You are beginning to get used to its varying not one but several thousandths.

Now make the same test in just this manner with the cross slide; then test the surface of the platen itself. By the time you have finished, you will have lost some faith in the trueness of a machine after it has been in use for some time; but you will have gained some very valuable information which will enable you to devise different ways and means to do correct work on the machine. I do not think that anybody will claim, after having made these tests, that absolute accuracy can be obtained by the method advocated by Mr. Sander.

It is true that by his method we can come reasonably close to true work, provided the conditions are all favorable and if in boring the holes we use the method of boring to a plug size, say 1/2 inch, then insert a plug in the bored hole and after having determined our distances from the center to center, measure with the micrometer or vernier over the plugs. If we correct our errors by moving the platen or knee as required, we will obtain good results, provided our starting point is located correctly. However, as in this case we have to use plugs anyhow and measure over them, I fail to see any advantage over the old-time button method. If absolute accuracy is required, I prefer the latter. Also, as I stated before, the conditions do not always exist where we can locate from the base or side of the jig, it being almost always immaterial whether the base or legs of a jig vary in distance from a given line on this jig. I consider it a waste of time and money to make the outside dimensions of a jig within a 0.001 limit, provided the leg sides are correct, either truly square, at an angle, or parallel, as may be required. It is true that what is called good workmanship in one shop is denounced as trash in another; that all depends on the degree of accuracy required, which is governed largely by commercial considerations.

A good many years ago, when I was traveling from shop to shop, to learn my trade as toolmaker for the second time, which apprenticeship by the way I have not yet finished, I happened to find a job in a shop which had the reputation locally (it being in a railroad town) of doing fine work. I was given a jig to make with some 25 or 30 drill holes in it; after laying out the holes with considerable care, I made preparations to swing it on the 18-inch lathe to indicate and bore the holes. The foreman asked me what I was going to do; I told him, and he said that was not the way they did it in their shop, but to take it to the drill press, put on proof circles and drill the holes and ream them afterward. I did not stay there long.

Philadelphia, Penn. L. F. C. GEORGE.

Calculations Respecting Epicyclic Wheel Trains—Errata

On page 631 in the tenth line from the top of the third column the value for "wheel of 120 teeth" should be 0. In the same column in the seventh line from the bottom the parenthesis should read

$$\left(1 - \frac{A\,D}{B\,C}\right).$$

As an instance of Japan's progressiveness a total of 69 units aggregating 60,000 horse-power capacity of the Curtis type of turbo-generator, manufactured by the General Electric Company has been installed in that country.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5 50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

During 1906 the AMERICAN MACHINIST *printed and circulated 1,083,205 copies, an average of 20,832 per issue. Of this issue 19,000 copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

Contents

	PAGE
The Microscope in the Tool Room	887
Comparison of the Productive Values of High-speed Tool Steels and Carbon Steels	893
The Growth of Cast Iron by Heating	895
Characteristics of Electric Motors	896
Standards for Hardness and Tempering	898
A Two-spindle Milling Machine	899
Drill Heads for Closely Spaced Holes	900
Test of Bearings	903
Modern Machine Molding Practice	906
Practical Letters From Our Readers: Adjustable Angle Plates....Recessing Tool Slide for the Turret Lathe....A Gas-heated Soldering Iron....Using the Beveled Side of the Wheel in Grinding Cutters....Does Steel Expand or Contract in Hardening?....Repairing a Broken Cylinder at Sea....Turning Rollers ....Straightening an Armature Shaft....Some Uses for Fiber....Rack for Displaying Blue Prints ....Special Vise for Die Grinding ....Producing a Difficult Piece Cheaply....A Gage for Interchangeable Work....Boring Holes in Jigs....Refiguring Blue Prints....An Erecting Frame....Combination Punching and Trimming Die	909-915
The Microscope in the Tool Room	916
Annual Meeting Mechanical Engineers	917
New Machines and Tool Room Appliances	

The Microscope in the Tool Room

Under this title is presented in another section of this issue an article describing a few of a multitude of purposes to which the compound microscope, when provided with cross hairs, may be applied. This instrument, while long in use in connection with measuring machines, seems to be little known among toolmakers in general, although its possibilities would seem to be almost unlimited. Like the test indicator, new uses for which are being found from time to time, the microscope would seem to have applications without number, especially when one stops to consider the possibilities presented by the combination of microscope and micrometer. The two instruments, the microscope and the test indicator, have their own particular fields of application (although at numerous points these fields overlap), and indeed it may be said that each instrument complements the other.

One great advantage of the microscope as pointed out in the article referred to is that in centering work on the face plate and doing certain other operations, the work may be carried along without preliminary laying out further than the scribing of fine lines on the surface; hence center punching of points of intersection of the various center lines is obviated and one source of error thus done away with. The indicating point of the microscope, namely, the intersecting cross hairs, being, so to speak, "out in the air," the "truing up" is done without actual contact between the test instrument and the work itself.

We all know how narrow an opening between two straight edges may be plainly discerned when light is admitted; owing to the magnifying power of the microscope, very minute errors in the work, as shown by the gap between the point under observation and the cross hairs, are detected readily and as easily measured when a micrometer screw is used in conjunction with the microscope. The instruments illustrated magnify about 25 diameters, which is considered by those who have used them sufficient for general purposes. Much higher powered lenses may be used for similar operations; but with increase in magnifying power comes difficulty in focusing, as with the high-powered lenses an exceedingly slight endwise adjustment of the instrument means throwing the latter entirely out of focus. Furthermore the field being so much reduced as the magnifying power increases, the sighting of the cross hairs on the particular portion of the work to be placed under observation becomes more difficult. Also with the high-power lenses there is of course increased difficulty in lighting the work; and further the working distance being decreased, there is more apt to be interference between the microscope and clamps or other parts connected with the work.

We expect in a later issue to publish something further upon this subject, showing a number of other important uses to which the microscope has been put. The subject is an important one and one in which we believe toolmakers and mechanics generally should be interested.

New Publications

HOW TO USE WATER POWER. By Herbert Chattey. 92 5x7-inch pages, with 23 illustrations. The Technical Publishing Company, Ltd., London, The D. Van Nostrand Company, New York. Price, $1.

The author has aimed to produce a compact book for beginners and students and one devoid of mathematics, except in very simple form. About one-half of the book relates to the shop use of water power in hydraulic presses, bending and riveting machines, hydraulic cranes and jacks. The latter portion of the book is devoted to water wheels of various types, pumps, etc.

DEVELOPMENT OF THE LOCOMOTIVE ENGINE. By Angus Sinclair. 668 pages, 6x9 inches; about 400 illustrations. Angus Sinclair Publishing Company, New York. Half leather. Price, $5.

Anyone who has attempted to collect facts along historical lines will appreciate the task accomplished by the author of this volume. The facility with which most men forget the incidents that you are most interested in—the details of a boiler or a valve gear that they have seen and handled—makes it almost impossible to secure the desired information, and we can appreciate the statement in the preface that the work of securing the material has been going on for about 30 years. In no other way can statements be verified so as to be fairly reliable. It is impossible to give an adequate review of such a book, as there are so many interesting points which should be mentioned. The book deals with the mechanical features of locomotives, traces the development along different lines, gives illustrations of many of the old engines that will be fondly remembered by many old-time railroaders and includes many portraits of those who have helped in one way or another to improve railroad facilities in this country. To anyone who is at all interested in locomotives or railways, the book will be a source of many an hour's pleasant reading, as the author has the faculty of giving facts without their usual dryness and weaves in many interesting anecdotes and letters. We believe this is a distinct contribution to the literature of the railroad, as nowhere else can such a collection of information, most of which has been verified in various ways, be obtained, and we hope that it will meet with the sale it deserves.

Meeting of the Mechanical Engineers

A Resumé of the Proceedings of the Twenty-eighth Annual Meeting of the American Society at New York, December 3 to 6, 1907

REPORTED BY THE EDITORS

The address of the retiring president, Frederick R. Hutton, dealt with the mechanical engineer as apart from the civil, electrical, mining and others, the function of engineering societies and particularly of the American Society of Mechanical Engineers.

A census of the present membership shows that over 53 per cent. are engaged as draftsmen or designers, local managers for manufacturers, shop executives, manufacturers or consulting engineers, so that he defines a mechanical engineer as follows:

"The mechanical engineer is one who by science and by art so adapts and applies the physical properties of matter and so controls the forces which act through them as to serve the use and convenience of man and to advance his economic and material welfare. He does this mainly by storing and liberating motor energy through machines and apparatus which he designs and installs and operates for the purpose of fostering and developing the processes of industrial production which use and require such power upon a large scale."

The advantages of the society to members were clearly set forth and the address closed with a suggestion for securing the coöperation of local engineers by encouraging the formation of local societies, bearing a local name, with a membership which would naturally contain both members and non-members. These would not be a part of the parent organization but would have a title as the ——— Society of Engineers affiliated with the American Society of Mechanical Engineers. They would be in no sense members, but only working with it as implied by the term "affiliated."

Some details of the coöperation were outlined, among them a plan for obtaining papers and discussions from the affiliated societies to broaden the scope of this branch of the parent society's work.

The report of the tellers was next in order and the election of the following officers for the ensuing year was declared: President, M. L. Holman, St. Louis, Mo.; vice-presidents, Prof. L. P. Breckenridge, University of Illinois; F. J. Miller, and Arthur West, Pittsburg; managers, W. L. Abbott, Chicago; Alex. C. Humphreys, Stevens Institute, and H. G. Stott, New York, and treasurer, W. H. Wiley, New York. The president-elect was escorted to the platform by John Fritz and Prof. John E. Sweet and was introduced to the society by the retiring president. The customary reception followed.

Wednesday Morning Session

At the opening of this session the secretary, Calvin W. Rice, read his yearly report, which was adopted, and the candidates for membership, which had been balloted on, were declared elected to full membership. This brought the total membership up to 3342.

A report of the land and building committee was then read by the chairman, Fred J. Miller, who urged on the members the necessity of subscribing to the land and building fund, as at present but 7 per cent. of the members had answered to the appeals of the committee, and owing to the present stringency it would devolve on the members to raise the fund required to liquidate this debt.

As the mechanical engineers of refrigerating machinery are to hold a congress in Paris, France, in June, 1908, it was voted that the council appoint a delegate from this body to attend the said congress.

This completed the business of the meeting, and the first paper was read, its subject being, "The Rational Utilization of Low-grade Fuels in Gas Producers,"* by F. E. Junge, Berlin, Germany.

This paper gives a brief exposé of the modern methods of utilizing inferior grades of coal and their by-products which have been developed and applied in the industrial pursuits of Germany. It is purported to appeal to those men in the United States who plan and exploit industrial enterprises, and to those who own large stretches of lignite and peat lands and care to utilize them most efficiently, both as to the capital returns and to the beneficial effects on the national industry. Mr. Junge showed how coal with 40 per cent. ash when used in boilers would boil water, but would not make steam, whereas a coal with 65 per cent. ash could be used in a producer to make gas and this gas used to run engines with or furnish power for machinery. Also that by locating gas producers at the mines the coal which is now wasted owing to its being too low grade could be turned into fuel or that by installing the proper apparatus this waste could be made into a merchantable product such as briquets.

He also showed that the fuel supply of a country is of such a national importance that it should be owned or controlled by the Government, so that the excessive waste that is taking place at present could be controlled to insure a permanent and steady supply.

It was also shown that the by-products, such as tars, oils, lubricants, etc., which were obtained were a source of revenue if the fuel was treated with scientific methods.

In the discussion which followed, W. B. Chapman said that the utility of fuels and their by-products was similar in this country to that of Germany, and that a coal which contained 65 per cent. of ash could be turned into gas with the gas producers as now used, but that they could not be worked successfully on caking coal which were a large part of the fuel products of this country and that the by-products did not appeal to the Americans as a source of revenue.

While great gains have been made in gas producers they were not as yet perfected to an extent which made them a commercial success in using up the low-grade fuels. The great need for this kind of work being larger units in gas producers so that the coal can be gasified in large central stations and producers that will work automatically in taking the coal in as well as deliver the gas and carry away the ashes so that a uniform and continuous flow of gas can be insured. These mechanical operations must be worked out so that the low-grade fuels in America can be used as the foreign producers are not suitable for American coals and it would appear that producers of the down-draft type were the best adaptable for this purpose.

Prof. Hiscock said that low-grade fuels need an excess of air to make them gasify properly, also that a low-heat gas can be used successfully to run a steam plant, but he thought that to operate a locomotive with a producer that used peat for a fuel was a point not well taken although coke made from peat and the by-products made use of was a good proposition and would no doubt work successfully.

Dr. J. A. Holmes, who is investigating these subjects for the Government at Washington, said that in his investigations he had found that the waste of fuels at the mines was something enormous and that he knew of one instance where a 25-foot vein of coal was being worked and but 4 feet of it was shipped away for fuel, although the difference in ash between the 4 feet that was being used and the 21 feet that was waste was but 4 per cent., and that the total average in this country of the coal that was left on the

*These papers are printed in full by the American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York, and can be purchased from them for a small sum.

ground and never used was over 50 per cent. Thus if some means could be devised for turning this waste into fuel a step would be taken toward preserving the fuel supply for future generations.

He said that in the ten years from 1895 to 1905 more coal had been taken out than in the 75 years preceding this, and that President Roosevelt was soon going to advise Congress in one of his messages to establish a special bureau which should have for its object the preserving of the minerals of the country.

Dr. Chas. E. Lucke, of Columbia University, said that he realized that it was of national importance that the low-grade coal be made use of in some way for fuel, but that he did not think it was a commercial proposition in this country at present as, in the first place, a gas-producer plant was too costly; second, the labor to operate one was excessively high as all of the fuel must be handled by hand and it was much more expensive to handle low-grade fuel than it was to handle a high-grade one, and third, that the length of run of a gas producer was so short that it would require a number of producers to make a continuous flow of gas.

Thus, while he thought the solution is near, it is not here yet and will not be until the producer is built that is continuous in its action.

J. R. Bibbins, of Pittsburg, gave the results of some tests which were made with Nos. 1, 2 and 3 buckwheat, rice and dust coal, and claimed that these showed that the handling of the coal was cheaper than firing it into boilers and that the great question was the difference in the coal rather than in gas producers.

Professor Kent said that he predicted some years ago that the gas producer would not be a success, and had not seen anything yet to change his views, and that we would always have the steam engine even though the gas men thought they had a better power.

The Apprentice System of the New York Central Lines

This paper was presented by W. B. Russell and it describes a comprehensive apprentice system which includes special shop instruction, carried on in the regular shop where the boy is under actual shop conditions, shop discipline, and shop environment. Combined with this training, educational classes are held during working hours, using courses of study, intensely practical in character and outlined to illustrate, explain and supplement the work in the shop by simple and direct methods, suited to the needs of the apprentice. The scheme starts at the bottom and is designed to increase the efficiency of the rank and file of mechanics. It is expected that exceptionally bright boys will profit most by the training offered and thus provide the necessary leaders. This plan is directed toward a broad and well constructed foundation of intelligent, thoughtful shop workers. The genius is left to reveal himself. The plan is now working, and working well, under a central leadership and providing for widely varying conditions in nine different places. It may not be, and probably is not, perfect, but it has proved capable of meeting a specific need with great promise for the future. It seems equally well adapted to small as well as large organizations, is applicable to almost any branch of manufacturing or repair work, and can be installed in most shops with talent already employed.

This paper caused a lengthy discussion and the position was taken by some of these that the instructions should be largely in the shop with a shop instructor, so that definite tasks could be given and the students taught what was actually wanted, also that a day rate should be paid and a bonus given to those that turned out more work than the average.

The students should be taught not only how to use the machinery and hand tools, but the brain as well, and they should be encouraged to read the technical papers and books as well as managing, so as to make them capable of filling positions of responsibility, such as foremanships and superintendency.

Excursion

Wednesday afternoon was devoted to excursions in the vicinity of New York and a large party visited the new Lackawanna terminal at Hoboken and many then walked back to Manhattan via one of the tunnels of the Hudson Companies, the party being escorted by members of the staff of Chief Engineer Chas. M. Jacobs. The tube through which the trip was made was started in 1874 by Mr. Haskin and because of financial troubles abandoned in the 80's after about 2000 feet had been finished. The present company undertook the carrying out of the work in 1907 and the tunnels will be completed early next year.

Color-photography

The Wednesday evening session was given over to an illustrated lecture by F. E. Ives on color-photography. Mr. Ives sketched briefly the historical steps in color-photography, and illustrated on the screen the results obtained from some of them. The pictures in colors thrown upon the screen by the use of a triple lantern, which superimposes three differently colored images on a single field, met with appreciative applause. Other pictures were thrown upon the screen from photographs made by the Powrie-Warner process and by the Lumière process, which is of French origin. These are thrown upon the screen with a single lantern instead of with the triple lantern required by the trichromatic principle. At the close of the lecture many members availed themselves of an opportunity to see the Ives kromoskop, the multiple slit defraction chromoscope and several negatives made by the processes which have been mentioned, together with some examples of trichromatic half-tone printing which were on exhibition in the foyer of the main auditorium.

Thursday Morning Session

Mr. Bibbins presented an abstract of his paper on a "Duty Test on Gas Power Plant," which reported an effort to throw some light upon the question of the general character of service and average operating efficiency obtainable from a modern bituminous producer-gas power plant, and whether the high efficiency claimed for it is maintained in commercial service. The results show an average coal consumption at the producer of 1.4 pounds per kilowatt hour, which is equivalent to 0.97 pound per brake horse-power hour, and 0.805 pound per indicated horse-power per hour, using Clearfield bituminous run-of-mine coal. In discussion Professor Kent objected to the common practice of comparing the performance of gas producers and gas engines under excellent operating condition with that of steam engines in a very general way and without the same element of economical running. Such comparisons, instead of being that the gas engine used only one-half to one-third as much coal per unit of power, should be specific between the actual performance of the gas engine and that of some of the high-duty steam engines, which are in the same general class as regards size, excellence of design and operation.

The last paper considered at this session was presented by Professor Lucke, on the "Control of Internal Combustion in Gas Engines." It has long been recognized that gas-engine indicator cards for apparently identical setting of valve gear and governor, or for constant loads, indicate variations where there ought to be constancy, and where constancy is obtained in steam engines. Three possible causes for these variations were presented under the headings of mixture variations, explosive waves and pre-ignition. In regard to mixture variation the conclusion is drawn that there seems to be little chance of securing absolute constancy with the present method of working. The explosive wave is examined in the light of the work of Mallard and LeChatellier, but is shown to be avoidable in some cases by giving proper form to the combustion chamber. Pre-ignition, intermittent in character and noted especially on producer gas is analyzed in the light of some recent experiments on the temperatures of ignition.

It is shown that the percentage of hydrogen in the mixture does not determine the tendency to pre-ignite but rather the ratio of C O to O or H to O. It is also shown that when pre-ignitions occur they cannot be charged to combustion alone, but are due to insufficient cooling of some part of the engine. They are

to be avoided by proportioning the fuel elements to the oxygen in the mixture and by more uniform and better cooling in the interior parts. The discussion which followed was mainly on two points, the first, suggestions in regard to improvements in gas-engine design in order to control or minimize the three causes of indicator-card variations as set forth by Professor Lucke, the second touched upon the use of the indicator, and several members attributed many variations in the indicator cards to improper setting of the indicator itself or to the inertia of some of its parts. A recess for lunch was taken at 1:20 p.m.

Thursday Morning Session on Foundry Papers

All the papers on Thursday morning dealing with foundry matters were presented in a separate section, meeting in room 6 over the main auditorium. These papers were read in abstract, and following the reading of each there was discussion of the subjects by various members. The first paper was entitled "The Foundry Department and the Department of Engineering Design," by William A. Bole.

In this paper examples are cited to illustrate the connection necessary between drawing room and foundry in the production of satisfactory castings. It is pointed out that designers' calculations are untrustworthy without the combination of theory with a working knowledge of the business of the foundry, and it is also shown that it is a matter of importance that the foundryman should be acquainted with the uses to which his product will be put. Owing to the absence of the author this paper was read in abstract by Secretary Rice. H. M. Lane, E. H. Mumford, and other members discussed various phases of the subject treated in the paper, and described different methods employed at various works for the production of sound castings. Upon concluding the discussion of this paper, a paper was presented in abstract entitled "Molding Sand," by A. E. Outerbridge, Jr.

This paper records the result of investigations in testing and mixing molding sand, and explains mechanical treatment for increasing toughness and porosity of sand. Sand test bars were made under uniform conditions and these bars were slid over the edge of a metal plate until they broke, the amount of overhang then being measured. It was found that by passing the molding sand through a centrifugal mixing machine the toughness was increased 75 per cent.

The third paper of this division was entitled "Power Service in the Foundry," by A. D. Williams, Jr.

It is pointed out in this paper that sufficient attention has never been paid to the foundry, or to what might be obtained in the way of power service for securing maximum production. It suggests some openings for improvement in foundry power service, and describes available apparatus for the purpose. The author read this paper in abstract, and a general discussion then followed, in which it was brought out that the crane service in the foundry is as a rule not as efficiently arranged as it might be, and in this connection H. M. Lane stated that he believed the locomotive crane has not been given the attention it deserved in foundries. He considered this a very suitable type of crane, as it can be operated inside and outside of the foundry, a lower door being provided at the end of the building to admit of the passage of the crane, without the necessity of erecting the structure necessary for overhead travelers. It was also pointed out that this type of crane is convenient not only for handling flasks, castings, etc., but for moving cars in and out, and shifting them about the yards.

A written discussion by Frank Richards was presented, taking exception to one statement made by the author that "as generally installed, with a central compressing plant, the use of compressed air requires an extensive transmission line, and in addition it is impossible to avoid leakage in the joints." In this written discussion Mr. Richards referred to various extensive plants where compressed-air pipe lines miles in length were in successful operation, and where there was no trouble with leakage at joints.

After other discussion along the same line, a paper was read entitled, "New Foundry for Bench Work," by W. J. Keep and Emmett Dwyer.

This paper illustrates a new foundry intended for bench work and designed to have a mezzanine floor. The foundry is 128 feet square, 50 feet high to the top of the monitors, 30 feet to the roof at the sides.

The next paper was entitled, "A Volumetric Study of Cast Iron," by Henry M. Lane.

In this paper the author calls attention to the fact that we speak of impurities in iron with reference to weight and pay no attention to the volume. The difference between the weight and volume of some of the impurities, such as silicon and carbon is startling when we see it compared, the latter occupying 6.79 per cent. of volume to one per cent. of weight.

An example of this is cited where a casting was overlooked in the pickling bath and remained several months. When removed it was of the same size, but very light and so brittle that it could hardly be handled without breaking. Analysis showed that most of the iron had been eaten away, leaving a skeleton of impurities.

This shows why long annealing and removal of carbon weakens the casting as if the carbon could be removed from malleable castings without other change, about 20 per cent. of the bulk of the casting would be removed.

Mr. Lane in presenting this paper illustrated his points by a series of interesting lantern slides. During the discussion Professor Stoughton showed some lantern slides which brought out points in opposition to Mr. Lane's theory.

Thursday Afternoon Session

The session of Thursday afternoon was started by R. Moldenke's paper on the "Specifications for Iron, Coke, and Methods of Testing Output," which stated that the smaller foundries usually employed standard materials that could only be spoiled through ignorance, while the larger ones purchased their supplies under specifications, and they were subject to careful inspection; a comparatively simple set of specifications for all foundry supplies insuring ample results.

For ordinary machinery castings (gray iron) the pig iron used as part of the charge should contain: Sulphur, not more than 0.05 per cent.; phosphorus, not more than 0.50 per cent.; manganese, not more than 0.80 per cent.; silicon, from 1.75 per cent. to 2.75 per cent., as specified.

For malleable castings (white iron) the pig iron used should contain: Sulphur, not more than 0.04 per cent.; phosphorus, not more than 0.225 per cent.; manganese, not more than 0.60 per cent.; silicon, from 0.75 per cent. to 1.50 per cent., as specified. A variation of 10 per cent. either way from the above figures may be allowed.

Concerning sulphur there is much to be ascertained, and in good coke this should be 1.2 per cent., but this often runs up to 2.0 per cent.

Modern ferro-alloys will eventually be limited to the richer grades as 80 per cent. ferro-manganese is being demanded today, while 50 per cent. ferro-silicon is much used and the 75 per cent. grade or better is specified by the wide-awake foundryman.

Oxygen in cast iron is far more powerful than even sulphur, yet its action is little understood; 0.03 per cent. of oxygen in solution in the iron as an oxide being sufficient to ruin white iron and weak castings, or those with pin holes under the skin are indicative of burnt iron.

In the matter of molding sands American foundry practice is far behind that of Germany or Europe, and the introduction of specifications for molding sand are of doubtful value.

The steel foundry is usually classed with the steel mill and apart from the foundry.

Such a variety of standards prevailed that the American Foundrymen's Association and the American Society for Testing Materials by individual members of each committee have adopted a set of specifications which depart entirely from

established procedure. This method is being generally used and is found to be superior to the old custom.

No discussion took place on this paper.

Foundry Cupola and Iron Mixture

The second paper was "Foundry Cupola and Iron Mixture," by W. J. Keep, in which he said: It does not pay to purchase a small cupola, as a large one may be lined with brick to make it of small inside diameter when the business is small and the diameter increased as the business grows.

The leading kinds of cupola have the same general proportions, which leave little room for improvement, and the results obtained depend largely on the melter.

The lining above the charging door will last as long as the shell, from this door to the point at which the metal melts is not cut away by heat but by the friction of the charge sliding down, at the melting point it is necessary to renew the lining about every six months and the bosh will need renewing about as often.

The charging door is from 12 to 17 feet from the bottom plate and cannot be placed any higher. There is no need of a tight door as a wire screen will keep the sparks from blowing out.

The distance of the tuyeres from the cupola bottom depends on whether coal or coke is used and upon the kind of castings made. A good way to form continuous tuyeres is by means of plates or segments one inch thick.

The quality of the coke is one of the most important things in changing the cupola, as if this contains 0.75 per cent. sulphur 0.03 per cent. will enter the castings and with the remelt of bad castings and sprues it is difficult to keep the sulphur below 0.08 per cent., which is the limit.

Limestone is the best flux, as it in a slight degree lessens sulphur, but its chief use is to make the slag fluid enough to run out the slag hole.

In the iron mixtures it is physical quality that the founder requires, and he would not trouble himself about the chemical composition were it not that by varying it he can vary the physical quality to some extent.

By decreasing sulphur, or by increasing silicon, the casting will be made softer. By decreasing sulphur, or by increasing silicon, or phosphorus, or both, fluidity is increased, and the iron is grayer and has less shrinkage. By increasing the manganese the sulphur is decreased or rendered less harmful.

Scrap is not ordinarily analyzed, though it often constitutes one-half the total mixture. Silicon runs 1.50, 2.00 and 2.40 per cent. in heavy, medium, and small soft scrap, respectively, and the sulphur is about 0.08 per cent.

In selecting scrap for a mixture, throw out all wrought, burnt, malleable and chilled iron, and all steel.

In the discussion some interesting points in cupola lining were brought out by E. H. Foster and G. R. Brandon, and in remelting scrap Mr. Burke advanced the fact that a remelt will make the iron of a closer grain on account of the action of the sulphur and that borings could be charged with a loss of only about 10 per cent. if they were put in a wooden box and the cover nailed on tight, so they would be held intact until they reached the melting zone.

Mr. Keep, in his conclusion, brought out the fact that the strength of castings could be increased nearly 25 per cent. by tumbling.

Foundry Blower Practice

In this paper Walter B. Snow gave an exhaustive series of tables, charts and formulas showing how to figure and the results obtained of the pressure, velocity, volume, horse-power, volumetric efficiency and mechanical efficiency, both singly and in their relation to each other for the different styles of blowers, such as fan and rotary, or positive pressure, and of both the double- and triple-blade rotary blowers.

He also gave tables showing the performance of the cupola with different types of blowers, pressure in ounces per square inch and the tons of metal melted per hour in cupolas of different diameters, also the horse-powers necessary to run blowers for different pressures and melting rates.

In the discussion, H. B. Parsons submitted many formulas and tables which were too lengthy to read and were submitted to the secretary to be printed in the proceedings of the meeting. Sanford A. Moss referred the members to the article on the "Flow of Air and Other Gases, with Special Reference to Small Pressure Differences," printed in the American Machinist, Vol. 29, Part 2, pages 368 and 407, which also gave a large number of formulas and other data on this subject. Edward N. Trump suggested that the Ventury meter be used to measure the air as with this from 0 to 250 lb. per square inch could be measured with accuracy.

Patterns for Repetition Work

This paper was presented by E. H. Berry, who said in part that a pattern which is run continuously for months and perhaps years clearly falls within the limits of this paper.

A distinction exists, based on output, between repetition and jobbing work. In the former slightly cheaper production justifies considerable expenditure in designing and constructing.

Pattern drawings are essential. Also coöperation between the drawing room and other departments. Drawings should show actual pattern dimensions, required accuracy, draft, parting and carding.

Standard flask sizes are desirable. Limits are given for one-man molds. Plate patterns—ordinary, "reversible" or "split"—as preferred. Complicated partings compel "open" carding. Details discussed are: Hight and spacing of moldboard cleats; unnecessary rounds and fillets; draft; dimensioning draft; runner sections; connection details; materials.

Accuracy is unnecessary where finish is allowed, but is essential at other specified points. Economical construction methods are outlined, and working instructions quoted. Excessive pattern duplication should be avoided. Precautions on new work are suggested. Carding different patterns is altogether undesirable. Important construction details are accuracy of rounds and fillets, and fittings of flash pins to gage.

Numerous sketches were given showing the location of the patterns in the mold, and the methods employed in parting them, and the paper was almost entirely devoted to metal patterns and their installation on moldng machines.

Some points of interest were brought out in the discussion by E. H. Mumford and Henry Lane, among them being the good results that were obtained by this system for the molding machine, and that drawings for patternmakers were badly needed in most factories, as the patternmaker could not be trusted to get the details on a pattern that was needed by the molder.

Some Limitations of Molding Machines

This was the next paper in order and was presented by E. H. Mumford, who gave a somewhat detailed discussion of difficulties such as holding machines must contend with, as conditions imposed on the machine are very great and their combinations greater still, so that it is difficult to state a fact in machine molding without almost immediately facing its apparent contradiction in an exception to the rule.

Briefly, limitations upon the machine are found in each of its operations and these are described in the paper.

Many of the limitations known to the present American machines are eliminated in the new French machines described, though not all of them, but the French machine promises to carry the art of power machine molding further in this country than it has ever yet been carried, and it has therefore seemed worth while to go somewhat fully into the characteristics of these machines.

E. Ronceray was called on and illustrated on the blackboard some deep-flask molds which the machine his firm in France had brought out recently could do. In this it differs from the American machines which are mostly adapted for patterns that are shallow and therefore use a shallow flask.

Chas. W. Stone showed the necessity of using heavy cleats on all bottom boards as otherwise the jolting of the machine would spring the molds out of shape.

Watts Room

At this point it was brought to the attention of the society that Mr. Fangay owned the house in which Mr. Watts had his private work shop and that they had kept the room and its contents just as Mr. Watts left it when he died and that in looking over the papers there Professor Sweet with others had discovered some rare prints, one of which contained a cut of the foundry and machine shop run by Mr. Watts. These documents were presented to the society for framing and preserving in its historical room.

With these was also presented the original correspondence between Robert Fulton and the committee of the French Government under Napoleon in relation to furnishing them with steamboats for use in their war with England. One of these was signed by Napoleon and they were ordered framed and hung on the walls of the society building.

The Evolution of the Internal Combustion Engine

This session was concluded with the reading of the above paper by Sidney A. Reeve, which was postponed from a former session and in which he said:

"Emphasis is laid at the start upon the fact that the demand which guides this evolution is not one for further refinement of efficiency, but for greater mechanical reliability and adaptability. In these directions the steam engine sets a standard far ahead of the gas engine. With this in mind the author reviews, first, the possibilities for further development of the explosive type of engine. These possibilities comprise the design of a variable-clearance Otto-cycle machine, and also the development of a high-pressure Lenoir-cycle engine. Both of these are broad types, capable of many modifications and adaptations to different services. Secondly, the attention is turned to the field of continuous combustion under constant pressure, and the development of a Joule-cycle machine which should follow closely steam-engine lines of construction. The author closes with the belief that the gas engine of the future, although possibly performing its combustion explosively, is to be less like the gas engine of today than like the steam engine of today.

This paper being of an historical nature, no discussion was had.

Thursday Evening Reception

The distinctly social feature of the meeting was the reception, held this year, for the first time, in the Engineering building. President and Mrs. Hutton and President-elect Holman received in the auditorium, assisted by Professor Sweet. Dancing was enjoyed on the sixth floor of the building, and a collation was served from 10 to 12. The attendance was very large and sufficient to tax the capacity of the dancing and supper rooms.

Friday Morning Session

The last professional session was held Friday morning, at which four papers were presented, which were: "The Specific Heat of Superheated Steam," by Prof. C. C. Thomas; "Engine Design Adapted for the Use of Superheated Steam," by Max E. R. Toltz; "Power Transmission by Friction Driving," by Prof. W. F. M. Goss and "Cylinder Port Velocities," by Jacob H. Wallace.

Professor Thomas' paper presented in graphical form the results of an extensive series of experiments made in such a manner that the accuracy of the result is accomplished and extending over a period of three years of continuous research. The various experiments were so made that they check each other and serve to verify the accuracy of the final results. The development and final form of the apparatus wer efully described, as well as the methods of making observations. The results were given in such a form as to afford an easy means of comparison with results obtained by various other experimenters in the same line. Also a Mollier-heat-diagram was included with the paper giving the results of the investigation in a convenient form for immediate use by engineers. The discussion turned upon the question as to the advisability of a specal research committee of the society to cooperate with the various experimenters and investigators in this particular line of work which is of such vital interest to steam users.

The paper on "Engine Design for Superheated Steam," by Mr. Toltz, summarized the advantages of superheated steam as follows: *a* It eliminates almost all cylinder condensation. *b* Its volume increases and the clearances in the cylinder are therefore reduced. *c* The efficiency of the "Carnot" process in the engine is raised. Some of the difficulties to be considered in the design of engines for using highly superheated steam are the difficulty of lubrication with the Corliss valve gear, the increased expansion due to the higher temperatures and the permanent increase in size or permanent expansion due to continued high temperatures. This latter feature enters not only into the elements of the design of the engine itself but also into the valves and piping for controlling and conveying the superheated steam. Mr. Toltz suggests double-seated poppet valves for small engines with slow piston speed and four-seated poppet valves for large engines with high piston speeds. Piston valves can also be recommended. In general it is advantageous to locate the poppet valves in the cylinder head, which makes a plain cylinder casting, thus doing away with the tendency to crack. No steam jacket is necessary for the high-pressure cylinder. The material of the cylinder should be uniformly distributed to prevent warping. Poppet valves are being used to a great extent in European practice and some of the latest types of engines have these valves for speeds of 230 to 240 revolutions per minute. The discussion of this paper covered a wide range, consisting of notes of experience in regard to the difficulties met with in handling superheated steam and with general features of design for these conditions of operation. It was pointed out that the workmanship on some of the European engines is of a most excellent quality and that some of the excellence of their performances should be credited to this fact rather than to the features of design alone.

The paper by Professor Goss on "Power Transmission by Friction Driving" is of such interest and of such direct application to machine design that it will be published in detail in a succeeding issue of the American Machinist. In general it gives the results of an enormous number of tests on various types of fibrous friction-driving wheels in contact with metallic-driven wheels arranged in such form as to be of immediate use to the machine designer.

The last paper by Mr. Wallace considered the velocity of flow of steam through engine ports and pointed out that this velocity depends upon the port opening and the piston velocity. For a constant velocity of flow during a stroke the port opening must be proportional to the piston velocity. If the piston velocity be applied graphically to represent port opening as in a Bilgram diagram a steam lap curve for a constant velocity flow would be established. A valve gear to afford that velocity of flow must provide the same port opening for the same crank position. A set of curves may be obtained by establishing other constant velocity curves by means of which the velocity for any crank position may be determined. No discussion was provoked by Mr. Wallace's paper.

The registration at this meeting is the largest in the history of the society, and at the close of the final professional session the number of members who had registered was 732 and the number of guests who had registered was 618, making a total registration of 1350.

According to a consular report, copper mining will soon be added to the industries of Jamaica. The deposits which it is proposed to work are situated principally in the parish of Clarendon, and the ore carries gold and silver. Two thousand acres of land have been acquired by mining interests, and shafts have been sunk.

The Long Island railroad will use concrete pile foundations for the new conduit line in the North Shore yards at Long Island City.

A Few Kinks from Hartford, Conn.

EDITORIAL CORRESPONDENCE

The result of attention to little details, especially in the manufacture of small articles, was illustrated in a recent visit to the shop of W. W. & C. F. Tucker, whose oil-hole covers are to be seen on many machines. The outer cover or sleeve has to fit very nicely in order to make them dust and oil tight; the fact that some are using them for air valves is pretty good evidence that they do fit.

This accuracy is secured by the well known but too little used method of plug sizing. The body is kept to size by the use of micrometer gages, and the sleeve is bored as nearly as can be. Then, before assembling, the sleeve is brought to exact size by forcing a hardened-steel plug through it, which sizes and burnishes this at the same time. These fit so nicely that when the oil hole is drilled through both sleeve and body, there is no bur which prevents turning, unless the drill is allowed to get very dull. This means that they fit about as nicely as possible and still turn easily with the fingers.

SPINNING JESSOP'S STEEL

The Taylor-Fenn Company build some interesting special machinery for cutting rubber into rings and similar shapes; their experience has brought out many interesting facts in this connection. The cutting of rubber is perhaps one of the meanest jobs on earth for a novice, and probably most of us would have to throw away any notions we might have on the subject before we could get on at all in the work.

Without going through the evolutionary steps of the process, the best form of knife that has been found is a circular disk with a cupped edge, the angle of this cupping and the size of the cutter being governed by the diameter of the rubber to be cut. The general appearance of the knife is as shown in Fig. 1, and the interesting part is that the cupped edge is spun over just as you would sheet brass.

These knives are of Jessop's steel, a sixteenth of an inch thick and well annealed. The central hole is drilled and they are fastened to an arbor or former of the proper shape, a roller brought against the edge and the metal slowly forced down to the proper angle. It would seem easy enough if it were anything but high-grade tool steel, but they do it without any fuss whatever.

MAKING A STEEL CLUTCH RING

Friction clutches are always attractive for power transmission, on account of the easy way in which they start when everything goes nicely. But the question of the clutch ring is very important, and when a motor-boat owner asked the Carlyle Johnson Company for a clutch to transmit 100 horse-power they decided that a steel clutch ring would be safer than cast iron, although that had stood well in up to 50 horse-power.

The making of this steel ring is not a particularly easy matter, as it has key and lips on the corners; but the superintendent, William Budde, solved it in a very neat way, and the method will be used on all the new high-power clutches.

Instead of starting with a solid ring and machining it out, he took a flat bar of steel of the right thickness to make the key, laid out the ring into a flat strip so as to find just where and how much to cut away and milled the surface to suit the desired shape of the inside, as in Figs. 2 and 3. Then he made a former, heated the ring, bent it to shape, tempered it to a spring temper, ground the outside and the job was done.

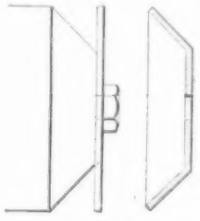


FIG. 1

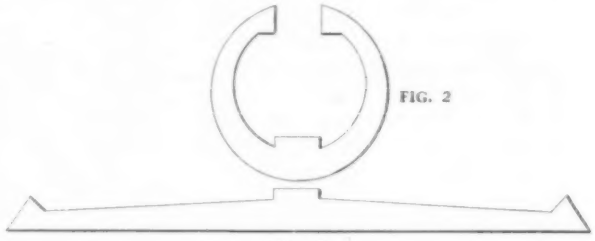


FIG. 2

FIG. 3

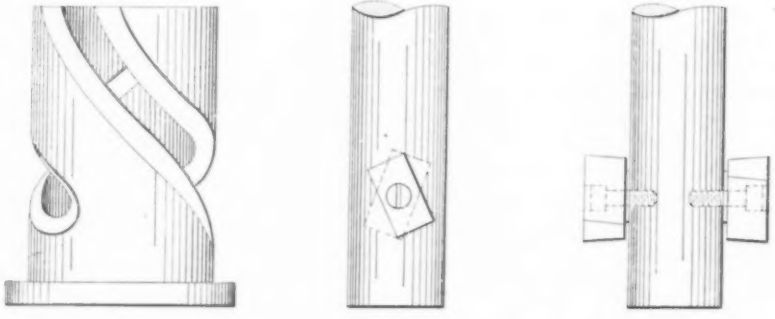


FIG. 4

A FEW KINKS FROM HARTFORD SHOPS

THE SPRING OF DRAWN STEEL

Among those who have been working at the gear-hobbing problem is the Dwight Slate Company, which has cut several thousand gears in this way. It has also fitted up a number of small machines for the Edison Phonograph Company which has for some time been hobbing all the gears used in its talking machines. This is of course a different proposition from hobbing a large steel gear, but shows that new ideas in similar channels exist in various parts of the country.

This company uses a large quantity of drawn steel for racks in sensitive drills. Mr. Marvel, the superintendent, has found that it cuts much better dry than with oil. There seems to be a very decided skin tension to the bars, and as soon as a cut is made the piece begins to give. With oil the cutter does not seem to bite as well as without it or else tears the metal badly; some racks cut with oil show a very decided unevenness of teeth that would make them very unsatisfactory in service. Cut without oil or other lubricant, this is not the case.

An instance of this springing was cited in the case of a small rack of about ½ inch square section and about 12 feet long. When the cut was completed and the rack laid on the floor, the center had sprung 18 inches out of line with the two ends.

One of their interesting processes is the flat nurling of center punches or similar tools. Instead of round nurls, as we are accustomed to seeing in screw machines and elsewhere, the nurls or nurling dies are flat plates; the piece of work is rolled between them by a reciprocating movement which forces the projections into the stock and raises portions of the stock into the depressions of the dies until the piece is satisfactorily nurled.

CUTTING A SPIRAL GROOVE WITH A KEY-SEATER

One of the features of the five-spindle automatic screw machine of the Union Machine Screw Company is a clutch which draws into the gear with a spiral motion and holds very securely. To get this it was necessary to have a spiral groove in the sleeve. So Mr. Spencer (one of the pioneers in screw-machine work and inventor of the Spencer rifle, which was used in the Federal army) rigged up a very neat scheme, as shown in Fig. 4.

The former resembles a twist drill with the core drilled out and is fastened under the table of the key-seater. The cutter bar has guiding blocks or wings which bear in the slots shown; as the bar is

pulled down, the blocks give it the desired twisting motion, and the spiral groove is cut in short order.

There is a corresponding groove on the outside of a sleeve which is cut in the milling machine in the usual way; a piece of round wire, bent to the required shape, fits into both grooves and forms the key. F. H. C.

English System of Gages for Standard Screw Threads

The Engineering Standards Committee of Great Britain has recently issued a comprehensive report on "British Standard Systems for Limit Gages for Screw Threads." This report contains complete tables of tolerances for bolts and nuts for both Whitworth standard threads and standard fine threads; in an appendix is included a table of allowances to compensate for pitch errors and a system of gaging for standard threads.

The gaging method is the invention of W. Taylor, of Messrs. Taylor, Taylor & Hobson, Limited, who has presented the patent rights to the Standards Committee, thus enabling the public to make free use of the invention. That portion of the report dealing with Mr. Taylor's method of simultaneously gaging pitch and effective diameter of bolts is given below. It should be stated here that by the term "effective diameter" is meant the length of a line drawn through the screw axis and at right angles to it, measured between the points where the line cuts the slopes of the thread. The gages are shown in the accompanying illustrations.

The Gages and How They Are Used

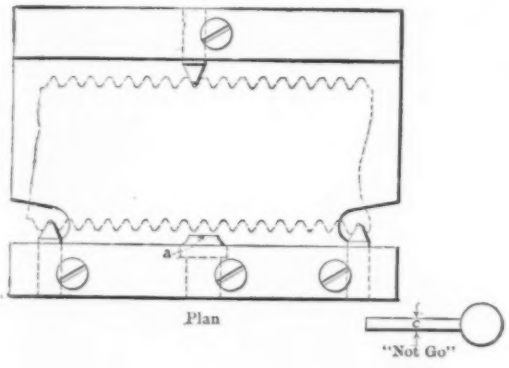
The three conical points, [Fig. 1] accurately ground to an angle of 55 degrees and truncated so as to clear the root of the thread, are distributed as follows: 1. Two are fixed on the lower jaw of the gage, so that the distance between them is an exact number of threads representing twice the length of screw contained in a standard nut of corresponding diameter. 2. The third is fixed on the upper jaw midway between the two points on the lower jaw, and the three points are set to a standard male gage having correct pitch and the maximum effective diameter [as given in the tables referred to above]. Opposite the single point is fixed the flat face *a*, which is adjusted so that the small cylinder *c* (of such a diameter that it will touch the thread about halfway down its depth) will just enter the thread of a bolt made to the minimum effective diameter [as given in the tables].

Then in testing, if the bolt enters the gage and the "Not Go" cylinder refuses to enter the thread, the bolt is within the limits for pitch and effective diameter laid down in the tables, while any error in pitch which may be present will be duly compensated by a reduction in the effective diameter.

Another form of gage designed to deal with a shorter length of thread than the last is described below. Here the "Go" and "Not Go" tests are applied by different gages.

Fig. 2 shows the "Go" gage, in which *T T* are plate gages of hardened steel, containing four truncated V-teeth of 55 degrees in angle, set as shown. The distance *l* represents an even number of threads immediately above the number contained in a length of screw equal to the nominal diameter of the bolt, while the distance *l* is one pitch shorter. These plates are secured to a suitable base, and are set to a bolt of correct pitch and maximum effective diameter. *S, S* are screws which can be so adjusted that the measurement is carried out exactly in the axial plane.

A snap gage, such as that shown in Fig. 3, answers as a "Not Go" gage, the cones being adjusted to a male gage having the minimum effective diameter. By preference this "Not Go" gage should be constructed so as to gage only near the mean depth of the thread.



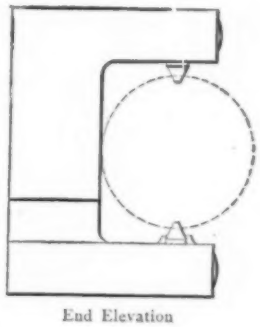
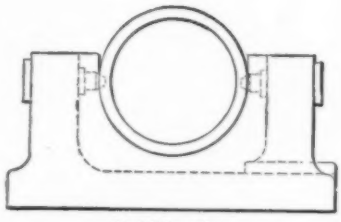


FIG. 1



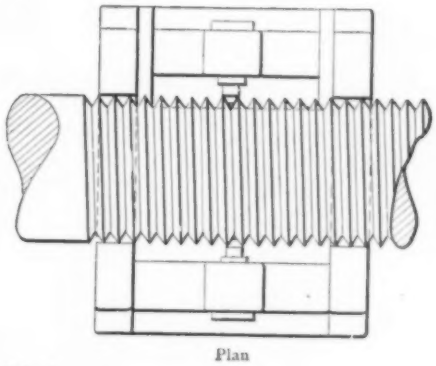
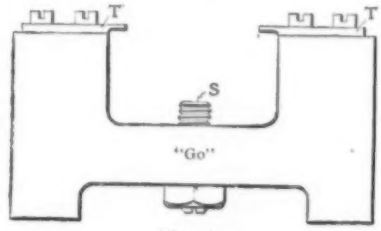


FIG. 3

ENGLISH SYSTEM OF GAGING SCREW THREADS



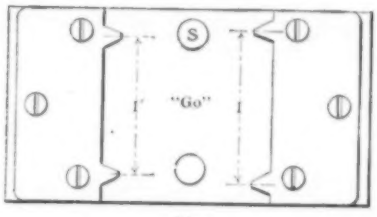


FIG. 2

It may be mentioned that an ordinary screw-ring gage may be used instead of the "Go" gage described above, provided that such gage has a length of thread equal to that in a standard nut, is of correct pitch, and has an effective diameter of the maximum dimensions allowable. The full and core diameters of such a gage may be cleared away, if desired, so that the pitch and effective diameter are checked alone. The difficulty of determining the accuracy of such a gage constitutes the chief objection to its use.

In a recent bulletin of the Bureau of Standards new determinations of melting points of the iron group are given as follows:

Iron.	Melting Point.	Purity.
Chromium.....	1505° C.	99.95
Cobalt.....	1464	99.99
Nickel.....	1435	99.95
Manganese.....	1207	98.99

Impurities, however, alter this temperature.

Some Alcohol Tests

By R. B. Whitman

The necessity of finding some substitute for gasolene as a fuel for the automobile engine, on account of its constantly increasing price and decreasing supply and quality, has for some time been occupying the minds of automobile builders and of companies who manufacture fluids which might be used as fuel in internal-combustion engines.

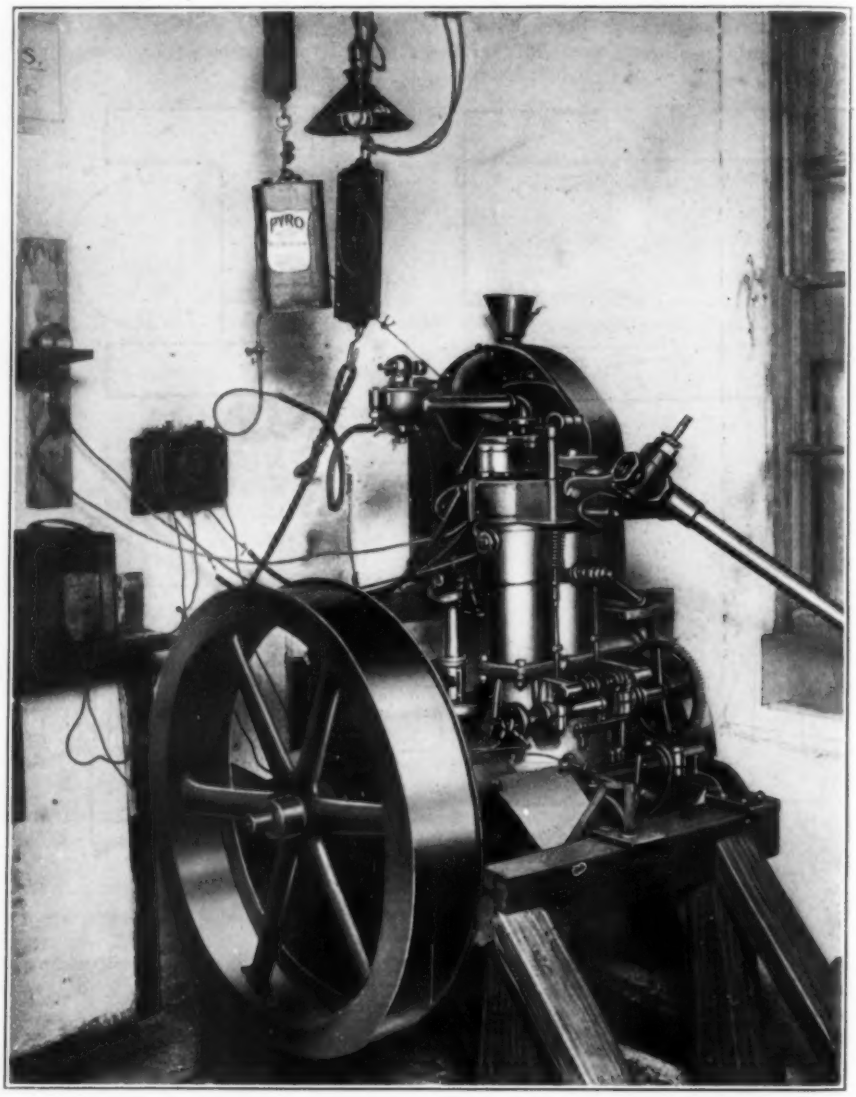
With this object in view, the United States Industrial Alcohol Company, of New York City, has been conducting extensive experiments at the New York School of Automobile Engineers, where a most extensive equipment of automobile engines and carbureters was to be found. The tests have covered a period of over three months, and various processes and apparatus have been tried in order to determine the operation of standard denatured alcohol in the engine.

The engine used was a two-cylinder Daimler automobile engine, with a 3¾-inch bore and 4½-inch stroke, 45 to 50 pounds compression, automatic inlet and mechanical exhaust valves. It is from eight to nine years old, and the mechanical construction is not to be compared with our present-day engines; nevertheless alcohol working so well in this "old timer" ought to work still more satisfactorily in a modern machine. The operation from no load to full load was perfectly regular, and in the comparative tests with gasolene the horse-power output was in favor of the alcohol. At the end of each week the engine was dismantled, to ascertain, if possible, the effect of alcohol on the working parts. Very little, if any, corrosion was noticed, and during the entire period of experiments not a spark plug had to be cleaned because of fouling. The exhaust was almost odorless, and there was absolutely no smoke from it.

As will be seen in the illustration, the carbureter is placed above instead of below the cylinders, and the exhaust manifold has been placed close up to the exhaust valves. The "Pyro" can near the top of the half-tone contains a solution which prevents alcohol from freezing when the temperature is considerably below zero.

The prevalent idea among the general public that an engine cannot be started with alcohol when it is cold is entirely erroneous. The problem of starting an automobile engine with alcohol is exactly similar to the one which confronts the automobilist when trying to start with gasolene in winter. The gasolene is not as volatile in cold weather; and in order to start the engine, a high state of vacuum must be obtained in the carbureter and suction pipe. This is the identical problem when starting with alcohol, and any carbureter in which a high degree of vacuum can be produced will start the engine, when cold, with alcohol.

In the tests about fifteen ordinary commercial carbureters were tried and every one worked, but with varying degrees of success. A peculiarity with some was that they worked best when turned upside down. The consumption of alcohol, when proper adjustments were made, in the best carbureters was about one-third more than with gasolene in this low-compression engine; but it is a well known fact that in an engine with high compression and designed especially for alcohol, the consumption per horse-power is about the same for both fuels.



APPARATUS WITH WHICH ALCOHOL TESTS WERE MADE

Alcohol has many inherent advantages over gasolene: its composition is always constant, as it is a chemical compound; it is much cleaner, leaving no residue in the cylinder; in case of fire, alcohol can be extinguished by water, while in the case of gasolene the water simply spreads it, consequently the alcohol can be stored with no risk.

In view of the above, it would seem that alcohol should soon enter into the automobile field as a fuel, and the general attention which is being turned to this fuel by the Government and automobile manufacturers, both in this country and in Europe, tends to verify this conclusion.

The fuel used in these tests was the commercial 94 per cent. alcohol mixed with 10 per cent. benzine and 2 per cent. wood alcohol, according to the Government formula. While the rated horse-power of the engine was only 5, with this fuel it was run up to 9 brake horse-power.

With an idea of decreasing the needless destruction of our woods and lessening the danger from forest fires, Massachusetts has a new law compelling the railroads to clean up the brush on both sides of their tracks and they are also considering the need of spark arresters for locomotives.

In the machinery line the Egyptian trade is very exacting. The patrons there wish to actually see the machinery set up and running, demand a guarantee on every machine and buy on terms involving part cash and part notes.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Vertical-spindle Milling Machine

Fig. 1 shows a vertical-spindle milling machine. The spindle is 4 inches in diameter, has 6-inch independent vertical adjustment, is driven by spiral gear and has 18 changes of speed by means of a two-step cone operating through a speed box giving nine changes in speed. This speed box, shown in Fig. 2, is of the sliding-gear type and has nine gears to give nine changes.

The spindle has an automatic feed in either direction on the cross rail, which is counterweighted, is raised and lowered by hand and is fitted with a quick clamping device consisting of shafts with right- and left-hand thread operating taper wedges, so that when the rail is brought to the desired position it can be quickly clamped from one point. The table is operated by stationary screw with revolving nut, has six changes of feed with rapid power motion in both directions.

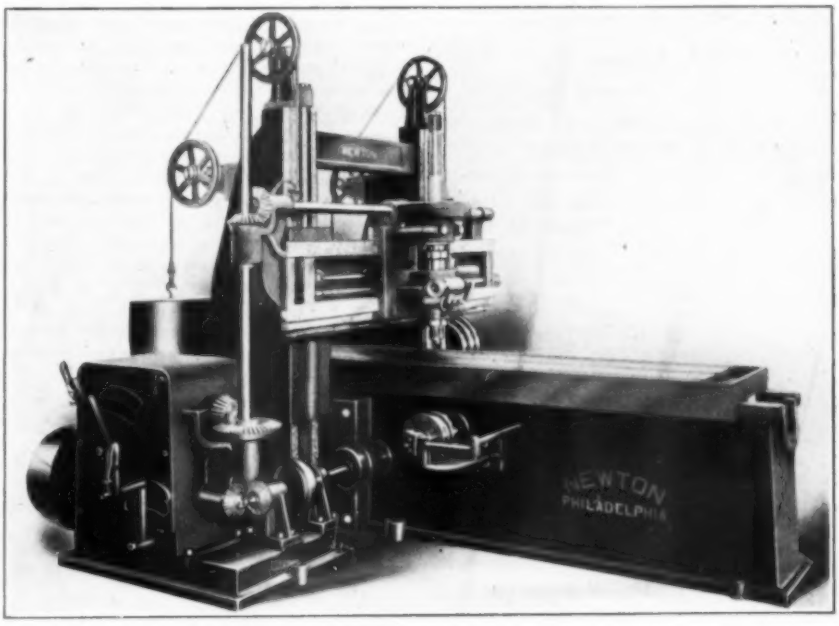


FIG. 1. A VERTICAL-SPINDLE MILLING MACHINE

Fig. 2 shows the gear-box drive. The driving pulleys *A* are mounted on the shaft *B*, which carries at its other end the miter gear *C* which drives the table-actuating mechanism. Mounted on the shaft *B* and driven by means of a spline is a long sleeve *D* carrying three spur gears *E*, *F*, *G*. The sleeve *D* is movable lengthwise on the shaft *B* by means of a lever and yoke, and the gears *E*, *F*, *G* can be brought into engagement with the three gears *H*, *I*, *J*, respectively mounted on an idler shaft *K*. On the shaft *O*, above the idler shaft *K*, is another slidable sleeve *Q* having on it the three gears *L*, *M*, *N*, which may by means of a lever and yoke be brought into mesh with the idler gears *H*, *I* and *J* respectively. Mounted on the end of the shaft *O* is a bevel pinion through which the power passes to a vertical shaft from which it is transmitted by miter gears to the worm which drives the milling spindle.

This speed box gives nine different speeds of the shaft *O* for each driving pulley, or 18 speeds in all. This milling machine was built recently by the Newton Machine Tool Works, Inc., Twenty-fourth and Vine streets, Philadelphia, Pennsylvania.

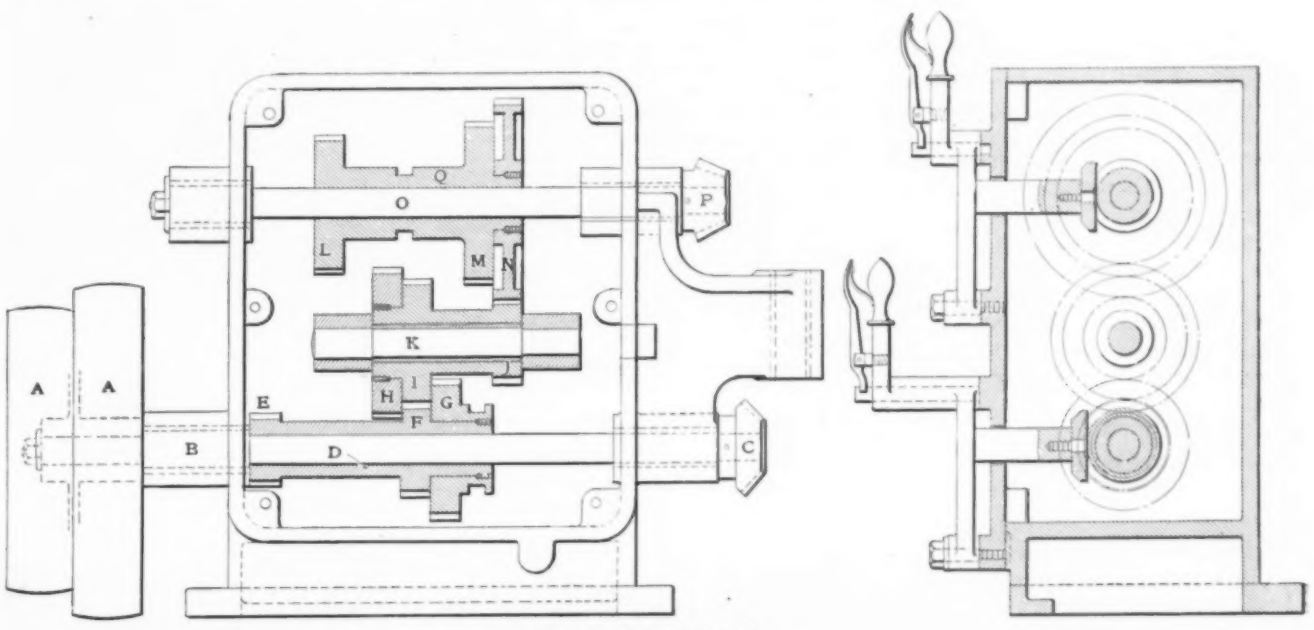


FIG. 2. THE SPEED BOX

A Flexible Shaft

A flexible shaft has been brought out by the Webb Manufacturing Company, Newark, New Jersey. This shaft is built up of successive layers of piano wire wound right- and left-hand. It is made in sizes from 0.10 inch diameter upward, and in lengths up to 12 feet.

A Clamp

The illustration shows a clamp for securing work in the lathe, planer, shaper, milling machine, etc. It is made of a suitable grade of steel and after forging is subjected to a special treatment which makes it more durable. These clamps are

A CLAMP

made in three sizes from 4 to 8 inches in total length by J. H. Williams & Co., Brooklyn, N. Y.

Personal

John C. McMynn, with Robert W. Hunt & Co., Chicago, has resigned his position, taking effect December 1.

G. A. Gallinger, heretofore at Chicago, has been appointed manager of the Independent Pneumatic Tool Company, at Pittsburg, Penn.

R. B. Jackson, formerly factory manager of the Olds Motor Works, is at present general manager of the E. R. Thomas Motor Company, Buffalo, N. Y.

Charles J. Girvin, formerly resident superintendent of the American Pipe Manufacturing Company, has accepted the position of superintendent of the Edge Moor Iron Company's shops at Edgemoor, Delaware.

Walter J. Bitterlich, machine designer with the United Shoe Machinery Company, Beverley, Mass., has recently severed his connection with that firm to engage on his own account in the business of mechanical drawing at Boston, Mass.

Obituary

William Cox, inventor and designer of mechanical calculating instruments, died on December 1, after a long term of poor health. Mr. Cox will be remembered by the mechanical reading public for the many ingenious and time-saving computers that his exceptional mathematical talents produced.

Business Items

The Northern Engineering Works has just added a second Newton cupola to the foundry equipment of the Lombard Iron Works, Augusta, Ga.

The Toledo Machine and Tool Company, Toledo, Ohio, is just completing a number of punch presses which are being shipped on orders to the Government navy yards at Washington and New York City.

Peter A. Frasse & Co. have opened a branch warehouse at 408 Commerce street, Philadelphia, Penn., where the sale of their specialties, such as Shelby steel tube, Poldi tool steels, high-speed drills, etc., will be especially looked after.

The Wile Power Gas Company, whose general offices have heretofore been in Rochester, N. Y., has now moved its offices to the works at 1688-92 Columbus Road, Cleveland, Ohio, where all communications should be addressed in the future.

At a recent annual meeting of the stockholders of the Independent Pneumatic Tool Company the board of directors were reelected and the annual statement submitted showed a large increase in business over the previous year. The recent additions to their plant at Aurora, Ill., with the large amount of new machinery installed, has so increased their facilities as to practically double their output.

The large increase in the business of the G. M. Yost Manufacturing Company, manufacturers of a complete line of vises, has made it necessary for them to greatly increase their facilities and they are at present constructing a new factory building at Meadville, Penn., which is expected to be finished about March 1, when they will install their entire equipment, adding about $5000 worth of tools to their manufacturing plant.

Trade Catalogs

Ferracute Machine Company, Bridgeton, N. J. Circular illustrating and describing Ferracute presses.

Norton Company, Worcester, Mass. Booklet on grinding wheels and machinery. Illustrated, 12 pages, 3½x6 inches.

National Machine Tool Company, Cincinnati, Ohio. Catalog of key-seating tools. Illustrated, 24 pages, 6x9 inches, paper.

The Nelson Valve Company, Philadelphia, Penn. Catalog H, describing various types valves. Illustrated, 52 pages, 6x9 inches, paper.

B. F. Sturtevant Company, Hyde Park, Mass. Bulletin No. 151, describing steam turbines. Illustrated, 16 pages, 6½x9 inches, paper.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machinery Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—The following second-hand machinery: one forging machine, two turret lathes, one bolt cutter, one 24"x16' engine lathe. Box 687, AMERICAN MACHINIST.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Mechanical engineer, experienced in selling, designing, and superintending the construction and installation of passenger and freight elevators desires to correspond with concern having facilities for manufacturing. Box 679, AMERICAN MACHINIST.

Our new up-to-date factory, well equipped for building light, medium or heavy machinery, desires to secure or contract for work; can guarantee all wood patterns that we manufacture; milling machine and pattern work a specialty. Steam Appliance Mfg. Co., Inc., Batavia, N. Y.

In evenings, invent for profit; waste of money to engage non-mechanical patent attorney; no other attorney is member both A. S. M. E., and A. I. E. E.; mail invention for free advice, etc. E. P. Thompson, M. E., registered patent attorney, Suite 40, 39 Cortlandt St., New York.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Machine Work Wanted—A New England foundry (with machine shop attached); A-1 reputation and thirty years' experience, desires to combine with a well established high-grade machine business, requiring castings; employing twelve to twenty men with competent manager; object being to reduce expenses and expand business for both parties; tide water shipping facilities, good business location; full investigation and references exchanged. For further information address Box 615, AMERICAN MACHINIST.

France; do you want to do business with France; I am contractor to the principal European Railway Companies, and have an important connection among the great constructors, engineers, mines, and automobile makers; I can introduce a suitable specialty; have you one? No antiquities required; would undertake agency of first-class high-speed machine tools for heavy cuts; only sound firms treated with; established 10 years in Paris; best references given and required. Address "Machinist," Care The Galignani Library, 224, Rue de Rivoli, Paris, France.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Position as chief engineer, or in charge of maintenance and repairs in industrial plant; have had experience in direct and alternating current power stations, machine shop, arc and incandescent lighting, motors, wiring and compressed air; not a

technical graduate, but have had wide practical experience in above lines and especially steam engine repairing, both Corliss and high speed; can figure all problems met in practice, understand indicators, valve setting, horizontal tubular and water tube boilers, and mechanical drawing; at present employed, but desire to change. Box 685, AMERICAN MACHINIST.

ILLINOIS

Position wanted in Chicago or immediate vicinity by a man 32 years old of good general and technical education (Yale); has had experience in the machine shop and drafting room and is now assistant superintendent of a factory in Connecticut. Address Box 686, AMERICAN MACHINIST.

As superintendent or assistant, well experienced in instrument and die work, good executive, method and piece work systems; age 30; any location. Box 675, AMER. MACH.

MASSACHUSETTS

Tool and machine designer with large experience wishes to change. Box 655, AM. M.

Superintendent of manufacturing plant open for engagement, either supervision or designing. Box 671, AMERICAN MACHINIST.

Machine designer and draftsman; 7 years' shop, 8 drafting experience; best references; wishes position. Box 672, AMER. MACHINIST.

Electric welding specialist wants to change positions; superintendent of production and machine construction 5 years; experienced designer and draftsman on automatic machinery. Box 616, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Change by a first-class and up-to-date machinist, position as assistant superintendent or general foreman; knows how to get best results from high-speed steel and from the men now employed; will furnish references. Box 690, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 695, AMERICAN MACHINIST.

Mechanical engineer; college graduate; one year shop, three years drafting experience, wants position. Box 694, AMER. MACHINIST.

Mechanical draftsman; 6 years of practical experience wants a position in New York, New Jersey or Connecticut. Box 662 AMERICAN MACHINIST.

Machine designer, technically educated, having 9 years' shop and drafting room experience; versed in latest factory, cost and specification systems, desires position. Box 682, AMERICAN MACHINIST

Electrical and mechanical engineer desires situation with manufacturing concern as salesman; 10 years' practical experience with wide acquaintance and selling ability. Box 681, AMERICAN MACHINIST.

Factory manager and organizer, cost expert and systematizer, experienced, practical man who can prove by past record ability to make good; will be disengaged Jan. 1, '08. Box 692, AMERICAN MACHINIST.

Electrical and mechanical engineer desires position as superintendent or assistant with manufacturing or industrial plant; expert draftsman with 10 years' practical experience. Box 680, AMERICAN MACHINIST.

Superintendent; experienced in office, drafting room, pattern, foundry and machine shop; capable of successfully handling large force of men, reducing costs, and increasing production. Box 688, AMERICAN MACHINIST.

Superintendent or assistant by practical man with broad and varied experience; designing and building special tools system; organiztion, etc.; modern, energetic and inventive; all grades; deeds not words. Box 656, AMERICAN MACHINIST.

Mechanical engineer, Junior A. S. M. E., at present employed; will be free about Jan. 1; desires a position in the vicinity of New York City; technical graduate with four years' experience in drafting and general engineering; concerns having only temporary position need not reply. Box 674, AM. MACH.

As manager or superintendent, an experienced man; technical education, practical toolmaker and machinist; an expert designer of large sheet metal drawing and forming dies, and also machines for accurate interchangeable cast iron and steel parts; large inventive ability; experienced in up-to-date systems and organization; now handling large force of men; wish to make a change. Box 678, AMERICAN MACHINIST.

Superintendent of large manufacturing and engineering establishment desires change; location, Greater New York or vicinity; superior executive and inventive ability and wide experience light, medium or heavy manufacturing; expert on tool, jig, fixture and special machine design; thoroughly up in modern shop practice and system; accustomed to handling successfully large numbers of men; permanent; reasonable salary. Address Box 696, AMERICAN MACHINIST.

OHIO

M. E. technical graduate, American; married man of 35 wants position as superintendent of apprentices or master mechanic in a factory making small interchangeable work where a rapid production is desired; also maintaining accuracy; A-1 references as to ability and character furnished, besides instructing ability of men and boys. Address Box 693, AMERICAN MACHINIST.

PENNSYLVANIA

Position wanted by mechanical draftsman and millwright; 10 years with one concern. Box 683, AMERICAN MACHINIST.

Foreman pattern maker, now employed, desires change; thoroughly experienced and up-to-date in all kinds of pattern work; best references. Box 689, AMERICAN MACHINIST.

First-class, rapid designer of marine steam turbines, steam engines and auxiliary machinery desires position; two years' shop practice and 8 years' drafting room experience. Reply to Box 677, AMER. MACHINIST.

RHODE ISLAND

Foreman; eight years' executive experience with modern machinery; 30; hustler. Address "Foreman," AMERICAN MACHINIST.

Position of trust or responsibility by experienced machinery executive office man; correspondent, systematizer, exact, thorough; go anywhere. Box 76, Pawtucket, R. I.

WISCONSIN

Wanted—Work in machine shop by willing beginner and student taking course in mechanical engineering. Box 673, AM. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

A machinery manufacturing company wants to engage a competent man familiar with machine shop, foundry and blacksmith work; with experience in modern tool practice, to take charge of works as manager; must have had experience as general foreman or shop superintendent; give experience, references and age; all communications confidential. Box 676, AMERICAN MACHINIST.

MICHIGAN

Opportunity for ambitious machinists to become foremen; advertiser wants several such men to act now as inspectors of parts used in building automobiles, and to become foremen when fitness for such position is proved; open shop; small attractive town. Address Box 647, AMERICAN MACHINIST.

NEW JERSEY

Help Wanted—Foreman over twenty-five machinists in electric works' twenty miles from New York City; state experience and salary wanted. Address "Factory," AM. M.

Wanted—An energetic capable man, thoroughly posted on modern methods of manufacturing on the interchangeable plan, and able to handle a moderate force of men, and invest a few thousand dollars, in an established and rapidly growing gasolene motor factory; such a man we want to put in charge of our shop and offer him a splendid chance to secure a permanent position and an independent income; factory located near New York City. "Prominent," AMER. MACH.

NEW YORK

Wanted—Draftsman with experience in automatic machinery. "O. V. S.," 74 Liberty St., Brooklyn.

Designer, expert on all kinds of tool work, competent to take charge of designing and drafting department of 30 men. Write stating age, experience and salary expected to E. E. I., 41 West 34th Street.

Machine shop foreman by New York City factory employing in this department of their works about 20 machinists on repairs, improvements and additions to and maintenance of plant; state fully experience, references and salary wanted. Box 691, AMER. MACH.

Wanted—An experienced draftsman of both mechanical and structural architectural drawing for a technical school; permanent position for first-class man. Apply by letter stating qualifications and experience in full, to Instruction Committee, P. O. Box 37, Station D, New York.

Toolmaker; A-1 practical mechanic experienced in the manufacturing of tools in all its branches and having experience in handling a large force of men; none but a man with such experience need apply; write stating age, experience and salary expected. "H. S. P.," 41 W. 34th St., New York.

OHIO

Top notch foundry superintendent wanted at once for new machine-molding gray iron foundry; the various buildings and equipment just being completed; strictly up-to-date including continuous pouring; applicant must be temperate in habits, of good character, aggressive, and above all, a good executive; full knowledge of molding machines and best application of patterns thereto absolutely necessary; give full particulars, references, where employed at present, and state salary required; all communications treated confidentially; no cheap man need apply. Address The Cincinnati Milling Machine Co., Cincinnati, Ohio.

Wanted—Milling machine foreman for commercial milling, to take charge of 20 men. Box 684, AMERICAN MACHINIST.

Wanted—Energetic, reliable man as foreman of up-to-date sheet steel department for range and stove work; good pay to right party. Write full particulars and references to "Fairman," Box 626, AMER. MACHINIST.

PENNSYLVANIA

Wanted—Assistant toolmaker; one able and willing to do other machine work. Give full details and experience, wages expected and how soon can report. The Shepherd Engineering Co., Williamsport, Pa.

WEST VIRGINIA

Wanted—Several first-class machinists for marine engine work. The Charles Ward Engineering Works, Charleston, W. Va.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

Steam engine for sale; 250 h.p. Greene automatic cut-off, double-crank, non condensing, horizontal engine, size 16 inches by 42 inches, two cylinders, with band fly-wheel 14 ft. by 31 in., speed 75 r.p.m.; built by F. C. & A. E. Rowland, New Haven, Conn.; this engine is in excellent condition; and has been in regular service in our factory for several years, being displaced by electric equipment in the enlargement of our plant. Winchester Repeating Arms Co., New Haven, Conn.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	93
Acme Machinery Co.	81
Adams Co.	104
Almond Mfg. Co., T. R.	78
Alteneder & Son, Theo.	76
American Blower Co.	81
American Emery Wheel Wks.	93
American Gas Furnace Co.	25
American Pulley Co.	83
American School of Correspondence	63
American Tool Wks. Co.,	8 and 101
American Tube & Stamping Co.	105
American Wood Working Mchy. Co.	105
Ames & Co., B. C.	74
Armstrong-Blum Mfg. Co.	76
Armstrong Bros. Tool Co.	67
Athol Machine Co.	85
Automatic Machine Co.	74
Baker Bros.	98
Baldwin Chain & Mfg. Co.	77
Baldwin Steel Co.	47
Barnes Co., B. F.	65

	PAGE
Barnes Co., W. F. & John	14
Barnett, G. & H.	36
Baush Machine Tool Co., 3d cover	
Bay State Stamping Co.	84
Beaman & Smith	15 and 78
Becker-Brainard Milling Machine Co.	23
Bemis & Call Hardware & Tool Co.	71
Besly & Co., Chas. H.	98
Bethlehem Steel Co.	87
Betts Machine Co.	6
Bickford Drill & Tool Co.	10
Bignall & Keeler Mfg. Co.	75
Bligram, Hugo	80
Billings & Spencer Co.	66
Binsse Machine Co.	36
Birdsboro Steel Fdry. & Mach. Co.	95
Blaisdell Machinery Co.	94
Blanchard Machine Co.	72
Bliss Co., E. W.	25
Blount Co., J. G.	30
Boston Gear Wks.	80
Box & Co., Alfred	82
Boynton & Plummer	75
Bradford Machine Tool Co.	5
Bradley & Son, C. C.	105
Bridgeport Safety Emery Wheel Co.	93
Bristol Co.	4th cover
Bristol, Wm. H.	36
Brown & Co., R. H.	79
Brown & Sharpe Mfg. Co., 45 and 4th cover	
Brown Hoisting Mchry. Co.	82
Brubaker & Bros., W. L.	76
Brunswick Refrigerating Co.	70
Bullard Mach. Tool Co.	35
Burke Electric Co.	92
Burke Mchry. Co.	103
Burr & Son, John T.	74
Burroughs Co., Chas.	68
Butterfield & Co.	77
C & C Electric Co.	91
Caldwell & Son Co., H. W.	94
Cammell Laird & Co.	87
Carborundum Co.	9
Card Mfg. Co., S. W.	14
Carpenter Tap & Die Co., J. M.	73
Carver File Co.	1
Case Mfg. Co.	82
Cell Drier Machine Co.	94
Chambersburg Engineering Co.	103
Champion Tool Works	75
Chicago Pneumatic Tool Co.	95
Chicago Raw Hide Mfg. Co.	77
Cincinnati Elec. Tool Co.	92
Cincinnati Lathe & Tool Co.	75
Cincinnati Machine Tool Co.	89
Cincinnati Milling Machine Co.	7
Cincinnati Planer Co.	24
Cincinnati Shaper Co.	106
Clark Cast Steel Cement Co.	86
Clark Auto. Telephone Switchboard Co.	75
Cleveland Auto. Mach. Co.	18
Cleveland Cap Screw Co.	74
Cleveland Crane & Car Co.	82
Cleveland Planer Wks.	75
Cleveland Twist Drill Co., 4th cover	
Cleveland Wire Spring Co.	88
Clough, R. M.	102
Coates Clipper Mfg. Co.	70
Coes Wrench Co.	16
Colburn Machine Tool Co., 30 and 104	
Cook Co., Asa S.	76
Consolidated Press & Tool Co.	103
Cowanesque Valley Iron Wks.	83
Crescent Forgings Co.	68
Crocker-Wheeler Co.	92
Crosby Steam Gage & Valve Co.	17
Curtis & Co. Mfg. Co.	83
Curtis & Curtis Co.	74
Cushman Chuck Co.	78
Davis Machine Co., W. P.	102
Davis, Rodney	80
Desmond-Stephan Mfg. Co.	102
Detrick & Harvey Mach. Co.	75
Diamond Chain & Mfg. Co.	77
Diamond Saw and Stamping Works	77
Dickinson, Thos. L.	93
Diehl Mfg. Co.	92
Dill Slotter People	65
Dixon Crucible Co., Jos.	84
Dreses Machine Tool Co.	61
Druckleib, C.	94
Dyson & Sons, Jos.	64
Earle Gear & Mach. Co.	80
Eastern Machinery Co.	74
Eberhardt Bros. Mach. Co.	80
Elmes Engineering Works, Chas. F.	75
Errington, F. A.	79
Evans Friction Cone Co.	98
Excelsior Needle Co.	72
Farrel Fdry. & Machine Co.	87
Fawcus Machine Co.	80
Fay Machine Tool Co.	30
Fellows Gear Shapr Co.	57
Ferracute Machine Co.	75
Firth-Sterling Steel Co.	89
Fitchburg Machine Wks.	29
Flather Planer Co., Mark	76
Foote-Burt Co., The	76
Fosdick Machine Tool Co.	16
Franklin Mfg. Co., H. H.	86
Franklin Port. Crane & Hoist Co.	82
Gang Co., Wm. E.	77
Gardner Machine Co.	93
Gem Mfg. Co.	105
General Electric Co.	90
General Pneumatic Tool Co.	83
Geometric Tool Co.	21
Gisholt Machine Co.	88
Gleason Works	4th cover
Globe Machine & Stamping Co.	76
Goldschmidt Thermit Co.	87
Goodell-Pratt Co.	77
Gorton Machine Co., Geo.	70
Gould & Eberhardt	76
Graham Mfg. Co.	85
Grant Gear Wks.	80
Grant Mfg. and Machine Co.	71
Gray Co., G. A.	20
Gray & Prior Machine Co., 72 and 103	
Greaves, Klusman & Co.	73
Gronkvist Drill Chuck Co., 69 and 78	
Hammacher, Schlemmer Co.	51
Hanna Engineering Wks.	76
Hardinge Bros.	74
Harrison & Knight Mfg. Co.	102
Harrington, Son & Co., Edw.	83
Hart & Cooley Co.	65
Hart Mfg. Co.	73
Hebert Sales Co.	98
Heller Bros. Co.	88
Hendey Machine Co.	53
Henley Pub. Co. Norman W.	23
Henry & Wright Mfg. Co.	102
Hill, Clarke & Co., Inc.	101
Hill Publishing Co. 36, 98 and	99
Hisey-Wolf Machine Co.	25
Hoefer Mfg. Co.	72
Hoggson & Pettis Mfg. Co.	92
Horsburgh & Scott Co.	80
Horton & Son Co., E.	78
Hunt Co., Robt. W.	74
Hurlbut-Rogers Machine Co.	75
Hyatt Roller Bearing Co.	76
Ideal Opening Die Co.	106
Industrial Oxygen Co.	87
Ingersoll Milling Machine Co.	70
Ingersoll-Rand Co.	95
Jacobs Mfg. Co.	79
Jantz & Leist Elec. Co.	92
Jenkins Bros.	88
Johnson Machine Co., Carlyle	69
Jones & Lamson Mach. Co., 12, 13 and	36
Juengst & Sons, George	67
Kearney & Trecker	103
Kelly Co., R. A.	73
Kempsmith Mfg. Co.	22
Kilbourne & Jacobs Mfg. Co.	76
Knight Machinery Co., W. B.	88
L. & D. Co.	75
Landis Machine Co.	105
Landis Tool Co.	47
Lapointe Machine Tool Co.	70
Lea Equipment Co.	28
LeBlond Machine Tool Co., R. K.	4th cover
LeCount, Wm. G.	85
Link Belt Co.	61
Lodge & Shipley Machine Tool Co.	4
Long & Allstatter Co.	73
Lumen Bearing Co.	87
Lunkenheimer Co.	84
Lyon Metallic Mfg. Co.	106
Manning, Maxwell & Moore, Inc.	96 and 97
Manufacturers Equipment and Engineering Co.	84
Manville Bros. Co.	17
Maris Bros.	82
Marshall & Huschart Mch. Co.	101
Mass. Saw Works	102
McCabe, J. J.	64 and 100
Merritt, Jos.	75
Merritt & Co.	74
Metal Hardening Solution Co.	86
Milton Mfg. Co.	51
Miner & Peck Mfg. Co.	76
Monarch Emery & Cor. Wheel Co.	93
Moore Co., Franklin	82
Morse Chain Co.	65
Morse Twist Drill & Mach. Co.	49
Morton Mfg. Co.	74
Mossberg Wrench Co.	74
Motch & Merryweather Machine Co.	100
Mueller Mach. Tool Co.	71
Mumford Co., E. H.	76
Mummert, Wolf & Dixon Co.	77
Nash Co., Geo.	102
National Acme Mfg. Co.	106
National Machinery Co.	75
New Britain Mach. Co.	70
New Haven Mfg. Co.	71
New Process Raw Hide Co.	81
Newton Machine Tool Wks.	11
Nicholson File Co.	17
Nicholson & Co., W. H.	70
Niles-Bement-Pond Co., 2, 3, 31, 34 and	100
Nolte Brass Co.	75
Northern Elec. Mfg. Co.	90
Northern Engineering Works	82
Norton Co.	57
Norton Grinding Co.	28
Nuttall Co., R. D.	80
Obermayer Co., S.	87
O. K. Tool Holder Co.	70
Olds Gas Power Co.	84
Owen Mach. Tool Co.	22
Parker Company, Chas.	85
Patterson, Gottfried & Hunter, Ltd.	77
Pawling & Harnischfeger	82
Paxson Co., J. W.	77
Philadelphia Bourse	94
Philadelphia Gear Works	80
Phosphor Bronze Smelting Co.	86
Pittsburg Auto. Vise & Tool Co.	85
Potter & Johnston Mach. Co.	53
Pratt Chuck Co.	79
Pratt & Whitney Co.	32 and 33
Prentice Bros. Co.	27
Prentiss Tool & Supply Co., 100 and	102
Queen City Machine Tool Co.	75
Reed Co., F. E.	59
Reed Mfg. Co.	85
Reichhelm Co., E. P.	73
Ridgway Dynamo & Engine Co.	91
Rivett-Dock Co.	3d cover
Rivett Lathe Mfg. Co.	3d cover
Rock Island Tool Co.	85
Rockwood Mfg. Co.	82
Rogers & Hubbard Co.	86
Rogers Wks., John M.	72
Roth Bros. & Co.	92
Rowell Co., W. G.	86
Safety Emery Wheel Co.	93
Sampson Co., Geo. H.	94
Saunders Sons, D.	72
Sawyer Gear Wks.	80
Schieren & Co., Chas. A.	105
Schmitz, August	73
Schumacher & Boye	9
Seaver, John W.	72
Sebastian Lathe Co.	69
Sellers & Co., Inc., Wm.	26
Seneca Falls Mfg. Co.	89
Shultz Belting Co.	77
Sibley Mch. Tool Co.	81
Skinner Chuck Co.	78
Slate Machine Co., Dwight	71
Sloan & Chace Mfg. Co.	21
Slocomb Co., J. T.	105
Smith Countershaft Co.	29
Smith & Mills	77
Smith & Post Co.	103
Smith Co., Wm. J.	9
Spacke Mach. Co., F. W.	94
Sprague Electric Co.	91
Springfield Mach. Tool Co.	15
Standard Connecting Rod Co.	84
Standard Engineering Works	74
Standard Gauge Steel Co.	87
Standard Motor Construction Co.	101
Standard Tool Co.	69
Stark Tool Co.	74
Starrett Co., L. S.	66
Stoever Foundry & Mfg. Co.	68
Straley & Hasbrouck	76
Struthers-Wells Co.	84
Sturtevant Co., B. F.	20
Tabor Mfg. Co.	71
Taylor & Fenn Co.	72
Taylor-Wilson Mfg. Co.	80
Toomey, Frank	101
Triumph Electric Co.	91
Trump Bros. Mach. Co.	78
Tudor Mfg Co.	103
Turner Brass Wks.	74
Union Twist Drill Co.	55
Universal Machine Screw Co.	67
U. S. Electrical Tool Co.	92
Van Dorn & Dutton	80
Vandyck Churchill Co.	68
Vitrified Wheel Co.	93
Von Wyck Mach. Tool Co.	75
Wagner Elec. Mfg. Co.	92
Walcott & Wood Mach. Tool Co.	77
Waltham Machine Works	77
Waltham Watch Tool Co.	98
Ward & Sons, Edgar T., 86 and	88
Warner & Swasey Co.	104
Warner Instrument Co.	71
Waterbury Farrel Fdry. & Mach. Co.	71
Watson-Stillman Co.	64
Wells Bros. Co.	64
Westcott Chuck Co.	78
Western Electric Co.	90
West Haven Mfg. Co.	88
Westmacott Gas Furnace Co.	74
Weston Elec. Instrument Co.	94
Whitcomb-Blaisdell Mach. Tool Co.	19
Whitman & Barnes Mfg. Co.	67
Whitney Mfg. Co.	43
Whiton Machine Co., D. E.	79
Wiley & Russell Mfg. Co.	102
Williams & Co., J. H.	73
Williamson Vise Co.	85
Wilmarth & Morman Co.	93
Wood's Sons Co., T. B.	103
Woodward & Powell Planer Co.	88
Worcester Machine Screw Co.	74
Wormer Machinery Co., C. C.	101

Classified Index to Articles Advertised

Abrasive Materials

Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.

Abrasive Materials—*Cont.*

Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

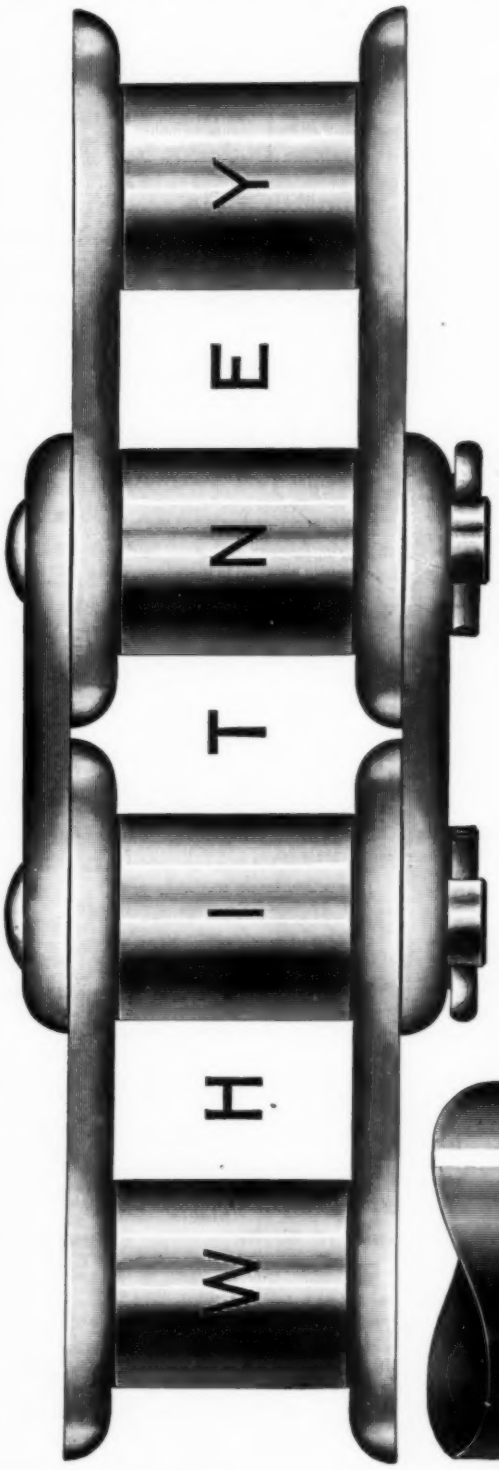
Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

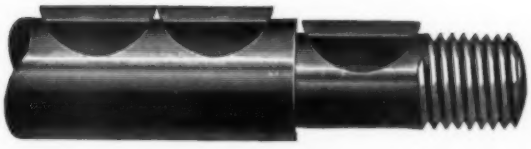
"WHITNEY" CHAINS

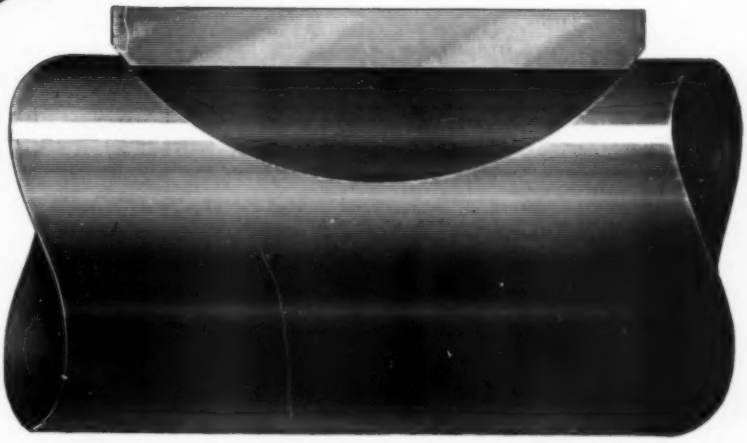
Hand (feed) Milling Machines

The Woodruff Patent System of Keying



The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Blower Co., Detroit, Mich.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Phila., Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.

Boring and Drilling Machines, Horizontal—*Cont.*

Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Carr & Co., Stuart R., Baltimore, Md.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

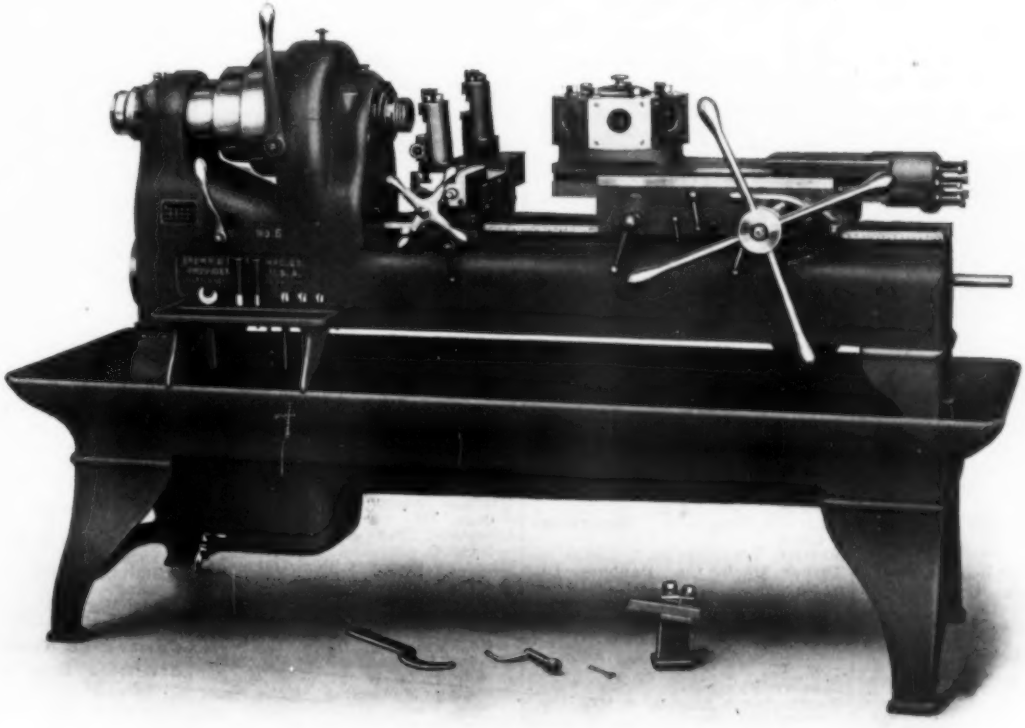
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

The Variable Feeding Mechanism On The No. 6 Plain Screw Machine

Gives A Range Of Feeds from .003" to .034" Per Revolution Of Spindle.



Driven direct from the spindle by chain and sprocket wheels—no intermediate gearing.

Eight changes, varying in geometrical progression, for each spindle speed. Will pull any cut within the capacity of machine.

Changes made, by lever on front of head, without stopping spindle or shifting a belt.

Descriptive Circular Mailed To Any Address.

BROWN & SHARPE MFG. COMPANY

PROVIDENCE, R. I., U. S. A.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Core

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Cell Drier Machine Co., Taunton, Mass.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Hebert Sales Co., New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Mossberg Wrench Co., Central Falls, R. I.

Countershafts—*Continued.*

Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Crank Pin Turning Machines

Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.

Cups and Covers, Oil—*Cont.*

Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Manning, Maxwell & Moore, Inc., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Manville Bros. Co., Waterbury, Conn.

Dies, Sub-Press

Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Ideal Opening Die Co., New York.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Master Plates and How They Are Made*

Accurate Results Obtained by Using Buttons and Plugs and Setting the Plate by Means of a Sensitive Test Indicator

BY E. M. KING

A master plate is a parallel plate of steel containing a number of holes, each of which corresponds to the center of some hole, recess, projection or curve in the piece of work or article for which it is made. These holes do not serve as guides for drills, counterbores or other cutting tools, but are used for correctly locating the master plate on the face plate of a lathe or other machine tool, each one of the holes fitting nicely over a true-running plug in the center of the face plate or spindle. For convenience all the holes should, if possible, be of one diameter.

In addition to these locating holes there may be also a number of holes in the plate for clamping screws and dowel pins for securing the work.

The piece to be operated on is fastened (usually soldered, or doweled and clamped) to the master plate, the whole then being strapped on the face plate, as shown in Fig. 1, and rotated or oscillated while the work is machined to correct measurements.

The position on the face plate of the work and master plate is changed from hole to hole as often as necessary to facilitate turning, boring, milling, grinding, etc., all of which operations (on small pieces) are usually done on the bench lathe.

Making a Pair of Plates From a Master

Suppose, for illustration, we are manufacturing some machine or instrument which in a certain place requires two plates like *A* and *B*, Fig. 2, these plates being exactly alike as regards outline and position of holes, only one is recessed out on the opposite side from the other. In other words they are right- and left-hand, or top and bottom plates. These plates are to be as near to correct measurements as possible.

The master plate for such a job is shown at *C*, Fig. 2. It has one hole for the center of each hole and curve in the work, or 12 holes altogether. The model blank is brought to shape by boring and, where it cannot be rotated, by milling with the bench-lathe milling attachment or by planing with a tool in the tool post of the slide rest.

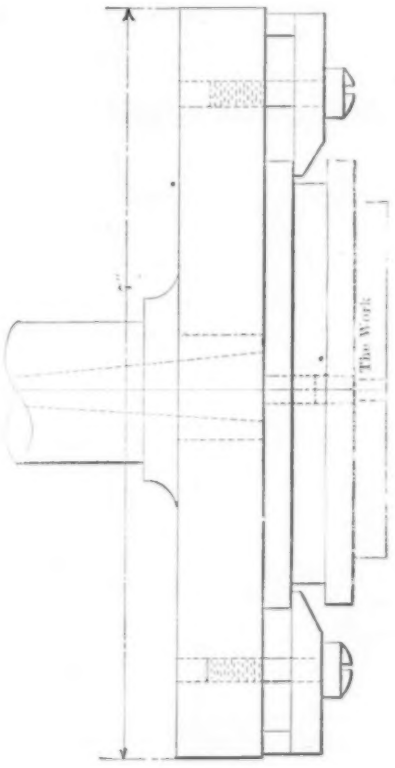


FIG. 1. MASTER PLATE STRAPPED ON FACE PLATE OF BENCH LATHE OR QUILL

It will be seen that if the holes used as centers for machining the piece were inaccurately positioned and the work made to correct drawing dimensions for two or more curves, these curves would not meet or blend together. As the plate *B* will in its turn have to be fixed on the other side of the master plate from that to which plate *A* was soldered, it is plain that it will not be correct and match *A* unless all holes in the master plate go through it perfectly square and measure up exactly the same on both sides. If the model is satisfactory, the master plate may now be used for making the blanking, piercing and shaving dies, also all necessary jigs, fixtures, depthing plates, etc.; or if desirable, it may be used for making the dies or molds for castings made by the die-casting process, the tools required of course depending on the material used in the plates and the method of manufacture.

In some cases the model (a watch for instance) is first perfected and then the master plate made by the model.

A Gear-train Plate

Fig. 3 shows a master plate for gear-train plates and connecting parts. The holes *a*, *b*, *c*, *d*, *e*, *f*, are for gear and pinion pivots, the others for dowels and screws. The limit of accuracy required is less than 0.0001 inch. From the foregoing

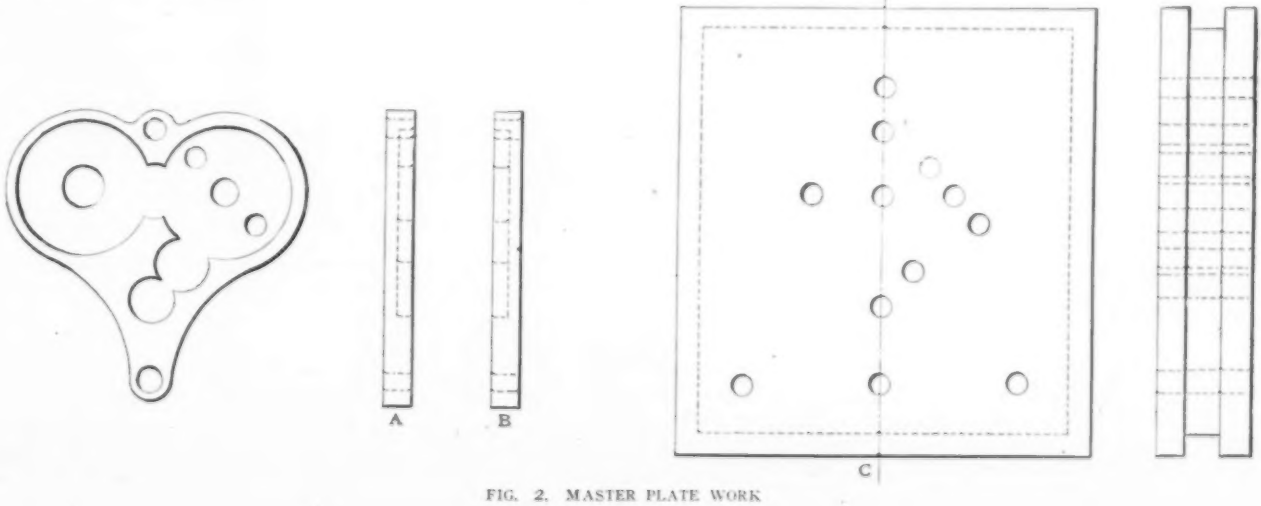


FIG. 2. MASTER PLATE WORK

*Copyright, 1907, by Hill Publishing Company.

it will be understood that the master plate, being the standard by which other tools are made, must be of more than ordinary accuracy. We will now consider the making of such accurate master plates.

In the first place the plate must be made perfectly flat, smooth and parallel on two surfaces. This is accomplished by grinding on a good surface-grinding machine and afterward lapping slightly on a cast-iron lap which has been made true by scraping to a surface plate (or originated by the well known method of scraping up three plates together) and then charged with fine carborundum or emery.

It is customary in some shops before the final grinding of tool-steel plates for master plates to heat them until the surface comes to a blue, it being believed that this relieves all strains and makes the plate less likely to change its shape. For some classes of master plates, Brown & Sharpe ground flat tool-steel stock is used without further grinding of the surface. This comes in strips up to 4 inches wide, the thickest stock, ¼ inch, being generally used for the plates.

There are several methods used for boring the holes in a master plate. If the shop in which the work is done possesses a precision dividing head or engine fitting the bench lathe, and if the work is small and a majority of the holes are in circles, they will probably be bored on the face plate of this head, using the milling attachment and a rotary boring tool. While this method is all right in some cases it is rather uncertain, especially when the holes are not in circles. The method first described here is the button method, it being suitable for a large variety of work.

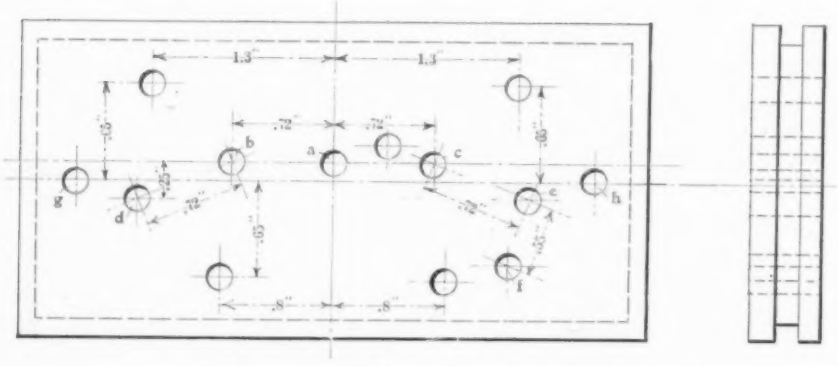


FIG. 3. MASTER PLATE FOR A GEAR TRAIN

Bench-lathe Equipment

Suppose we wish to bore the plate shown in Fig. 3, it being already lapped true as described. For this work we will need a bench lathe in first-class condition, with a face plate which is perfectly flat and smooth and which runs in a true plane. A better plan would be to use a face-plate quill and quill rest, as shown in Fig. 4, which illustrates the quill rest, face-plate quill and driver of the Pratt & Whitney bench lathe. Owing to the design of these quills, they can be very accurately constructed, and, as the drive is taken from the lathe spindle by means of the quill driver which enters the spindle like a chuck while its open end slips over the clamp dog on the rear of the quill, there is no strain nor jar due to the action of the belt, to affect the accuracy of the quill.

The face plate is solidly and permanently attached to the quill spindle, which has a small taper hole in the end for the insertion of taper pins which can be ground true on the projecting end for the purpose shown in Fig. 1. The face plate must be ground true. The quill with the face plate is taken from the quill rest, the face lapped smooth by just passing it over the lapping plate, and the quill returned to place.

As the master plate shown in Fig. 3 is a little larger than the ordinary 7-inch bench-lathe swing, it will be necessary to have raising blocks for the headstock, slide rest and also for the quill rest, if we use one.

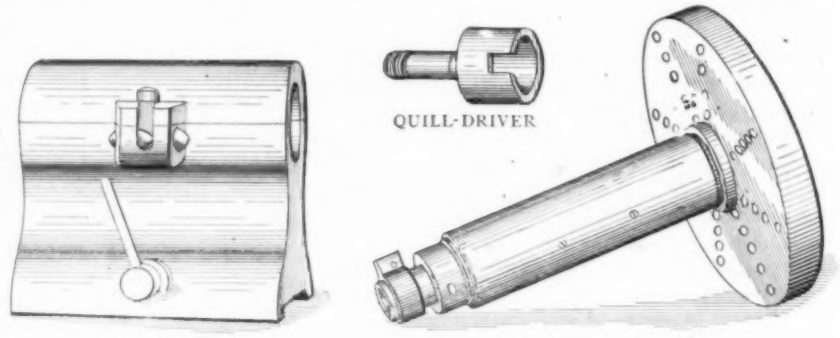


FIG. 4. FACE-PLATE QUILL EQUIPMENT FOR BENCH LATHE

An Indicator and Other Tools

Almost all the tools necessary for this job are shown in the half-tone, Fig. 5. These consist of, first of all, a sensitive test indicator *A* showing very distinctly a movement of 0.0001 inch (this indicator multiplies 170 times); two or three buttons *B*, say 0.250 inch diameter and 0.3 inch high (though a 0.5-inch button is preferable where possible to use it); three or more plugs *C* of two different diameters each, the large or body size corresponding in diameter and length to the buttons, the small size fitting the holes in the master plate (in this case 0.160 inch); a boring-tool holder and tools *D*; a reamer not shown; some internal laps *E*; external laps *F*; plug gages *G*; a simple hight gage *H*; and one or two straight edges, not shown. Button *J* is similar to *B*, only larger.

The buttons and plugs are hardened, ground and lapped. The buttons and large diameter of plugs are lapped to exact standard size. A good way to do this is to take a standard 0.250 plug gage which we are sure is correct and then lap the buttons and plugs until we can detect no difference between them and the standard when they are at the same temperature, using the micrometer as a gage with the spindle locked. The buttons are ground square on the bottom at the same setting when the diameter is ground. The shank on the right-hand end of the plug *C* is for the purpose of holding the plug in the chuck while grinding both diameters and the shoulder which rests against the master plate; it is also convenient for removing the plugs when the work is on the face plate. The reamer may be 0.0001 or 0.0002 smaller than the finished diameter of the holes. Two of the internal laps shown are made of copper and one of lead. Such laps are also easily made from round rods of soft solder by drilling a small hole and driving in a taper arbor having one or more flat sides, the outside then being turned off. The external laps *F* are copper. The gages shown at *G* are of slightly different diameters, the correct one being 0.160 inch.

Locating the Work on the Face Plate

Having these tools ready, we proceed with our master plate, laying it out by means of a surface gage or a vernier hight gage with scribing attachment; where the holes are to be bored, smaller holes are drilled and tapped part way through to fit the button clamping screws. Now one of the buttons *B* is secured by a screw over hole *a* in the master plate, Fig. 3, and located with the

vernier hight gage, the simple hight gage shown at *H*, Fig. 5, or by both together. The master plate with the button attached is then strapped loosely on the face plate with the button approximately central with the spindle. The indicator is clamped in the tool post, the contact point being about on the center as regards hight and touching the button either at the movement down to 0.004 inch, this means that the button is less than 0.000012 inch out of correct position.

The surfaces of both master and face plates being true and smooth, strapping down tightly will not make any change in position. It is advisable to try the indicator against the surface of the master plate to make sure that it revolves in a

Boring the Second Hole

The second hole *b*, Fig. 3, is next to be bored out. In order to locate the button for this hole, a plug *C*, Fig. 5, with small end 0.160 inch diameter and body exactly 0.250 inch, is inserted in the first hole *a*, and a button then placed over the hole already tapped at *b* and attached by

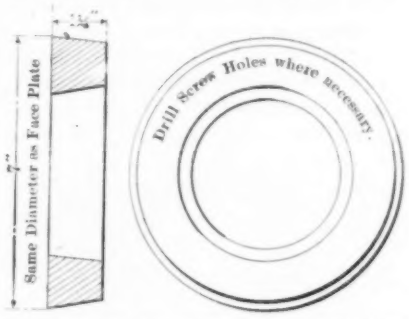


FIG. 6. LEAD RING FOR COUNTER-BALANCE SEGMENTS

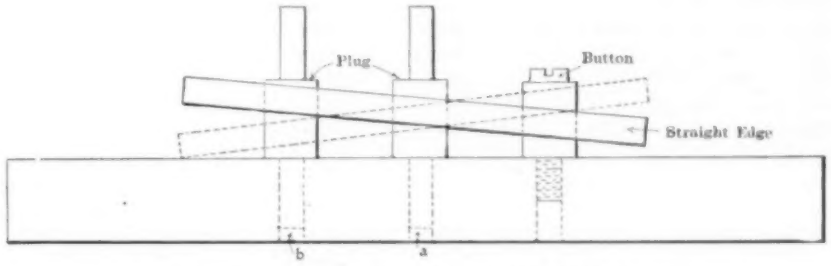


FIG. 7. SHOWING METHOD OF USING STRAIGHT-EDGE ON BUTTONS

back or front. The lathe is rotated and the master plate rapped until it is in such a position that the indicator pointer shows no movement—or almost no movement. As the indicator multiplies 170 times, 0.0001-inch movement of the button would move the pointer over the scale 0.017 inch; or 0.0001-inch eccentricity of the button would show a pointer movement of 0.034 inch. If we bring the pointer true plane. After removing the button, drill, bore and ream the hole, paying particular attention to the boring and leaving but very little for the reamer to cut; in fact, the latter is run through merely to scrape the hole. Next take off the master plate and lap the hole, turning the lap by hand with a small handle or dog until the hole is a good fit for the plug gage.

a screw and washer. This button is located on the same horizontal line as the plug placed in hole *a*, by placing the master plate on one edge on the surface plate and sliding the hight gage shown at *H*, Fig. 5, under and touching both plug and button. This hight gage, it will be noticed, is merely a square block carrying a fine-thread spherical end screw which may be readily adjusted. The correct

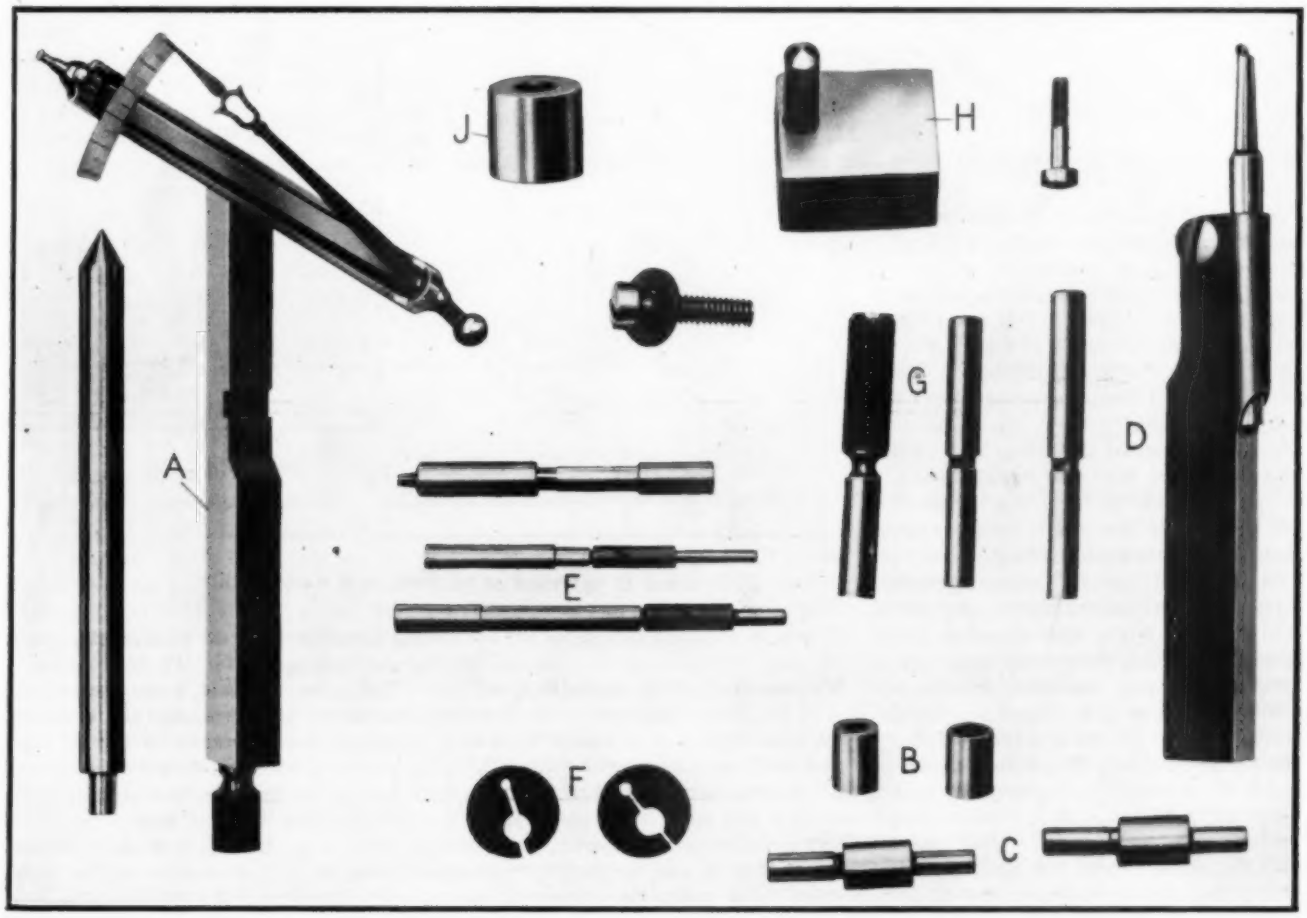


FIG. 5. A SET OF TOOLS FOR MASTER-PLATE WORK

distance from the plug in hole *a* is found by measuring over both plug and button with a 1-inch micrometer caliper, of course deducting 0.250 inch from the measurement. This is the important measurement and no pains should be spared to get it correctly. The master plate is now placed again on the face plate and the button trued up. The work is balanced conveniently by segments cut from lead rings like the one shown in Fig. 6, holes being drilled for the attaching screws. After trying the indicator again on the button, also on the surface of the plate, the hole is bored, reamed and lapped the same as the first hole *a*. When plugs are inserted in the two holes *a* and *b* and the distance measured, there should be no measurable error.

Locating and Boring the Third Hole

The button for the third hole *c*, Fig. 3, is located in a similar manner to the one for the second hole *b;* but for final adjustment a good method is to place plugs in holes *a* and *b* and use a straight edge on the three cylinders (the two plugs and the button), as shown in Fig. 7, moving it up and down as indicated by the dotted lines and noting on which cylinder it fulcrums, then trying it on the other side of the button and plugs. A still better way is to have two straight edges, one on each side of the plugs. Then it will be instantly detected if both straight edges do not act exactly alike.

FIG. 9. A MASTER INDEX PLATE

As we cannot use the ordinary 1-inch micrometer for measuring the distance from *a* to *b* or *a* to *c* when the plugs and buttons are in position, we must use something else. A Brown & Sharpe 3-inch or pocket vernier caliper is a very convenient tool for such work. In this case we use it simply as a snap gage, setting it to the outside measurement over the plugs in holes *a* and *b*, then rapping the button for hole *c* until, when gaged with the vernier thus set, the touch is exactly the same as for measurement *a b*.

A 2-inch micrometer may also be used to measure the distance from *b* to *c*. When the third hole *c* is bored, we should have these three holes exactly in a straight line, hole *a* being exactly central between holes *b* and *c*.

If the outside of the master plate from which we have been working is not now exactly parallel with the line through the centers of holes *a*, *b* and *c*, it can easily be made so by lapping.

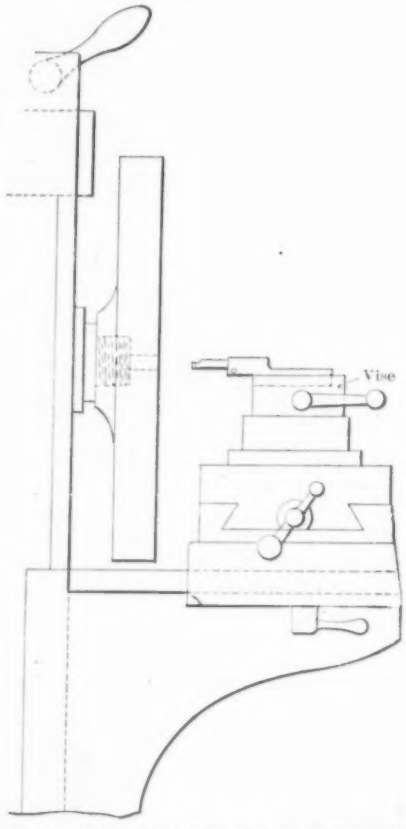


FIG. 10. USING A FACE PLATE ON THE MILLER

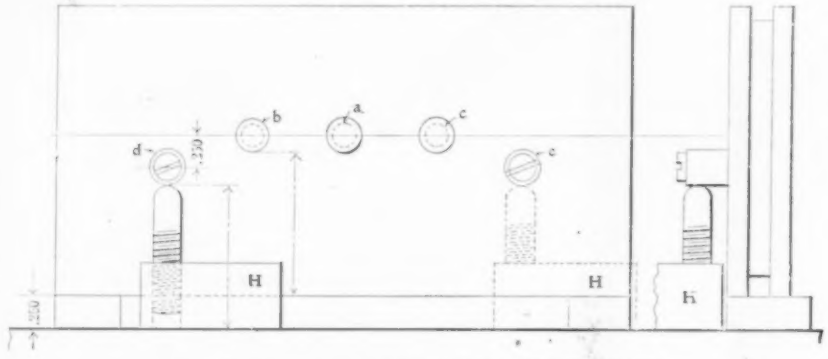


FIG. 8. SETTING THE BUTTONS ON A MASTER PLATE

Further Operations

We next set buttons for holes *d* and *e*, Fig. 3, using the comparative method as much as possible, that is, making distances *b* to *d* and *c* to *e* equal *a* to *b* and *a* to *c*. We can also figure out distances *a* to *d* or *a* to *e* and make them equal, using a 2-inch micrometer as a gage. The hight gage *H*, Fig. 5, can be used for setting buttons for *d* and *e* the correct distance from the center line through holes *a*, *b*, *c*, without altering the adjustment of the gage from the former setting for the button for hole *b*, by putting two accurate 0.250-inch parallel blocks or gages under the edge of the master plate; or if the other edge of the master plate (the top edge in the illustration) has been used to work from, a 0.250-inch parallel block can be put under the hight gage, both being slid together under the buttons.

The scheme with the pair of 0.250-inch size blocks under the master plate will be clear from Fig. 8, which shows the hight gage *H* as used for setting the button for hole *d*, the adjustment of the gage remaining unchanged from its original setting for locating the button for hole *b*.

Another way is to use one of the straight edges in contact with plugs in holes *a*, *b* and *c*, feeling with a 0.250 gage between the straight edge and buttons *d* and *e*. Finally the distance from *d* to *e* may be tested with a 3-inch micrometer. Holes *f*, *g*, *h*, Fig. 3, may be located in a similar manner. If careful work is done as outlined in locating and boring, the holes will test up equally well on either side of the plate.

A Master Index Plate

From the fact that, with the button method, comparative measurements of any number of holes or distances are easily made, it is particularly suitable for index plates and similar work. Fig. 9 shows a plate having nine holes, one in central position and eight others in a circle. The plate may be used for indexing directly or as a master for grinding the notches in other plates which are perhaps hardened; or we may have a hardened rim permanently attached to the original plates, using the holes for indexing during grinding only, or in case of repairs, or for testing.

The holes 1, 2 and 3 are located the same way as the three holes *a*, *b*, *c* already described in connection with Fig. 3. Hole 4 is located an equal distance from holes 2 and 3, the distance from 1 to 4 being of course the same as from 1 to 2 and from 1 to 3. Hole 5 is similarly located to hole 4, and preferably at the same time. The other holes are also located by comparison of distances one with another.

With one gage, micrometer, or vernier

caliper once set to gage the radial distances 1 to 2, 1 to 3, etc., another set to gage the chordal distances, and a good smooth plate, it is possible to set the buttons for the holes without a measurable error, even on quite large work.

Work on the Milling Machine

For larger work than can be handled on the bench lathe, even by using raising blocks, a universal or plain horizontal-spindle milling machine fitted with a large face plate on the spindle, as shown in Fig. 10, can be used. This face plate should contain numerous tapped holes for use in strapping on the work, instead of the six or eight slots usually seen in engine-lathe face plates. The vise of such a machine forms an excellent tool holder. This arrangement is preferable to a large engine lathe with a rocker adjustment under the tool and no graduated dial on the cross-slide screw.

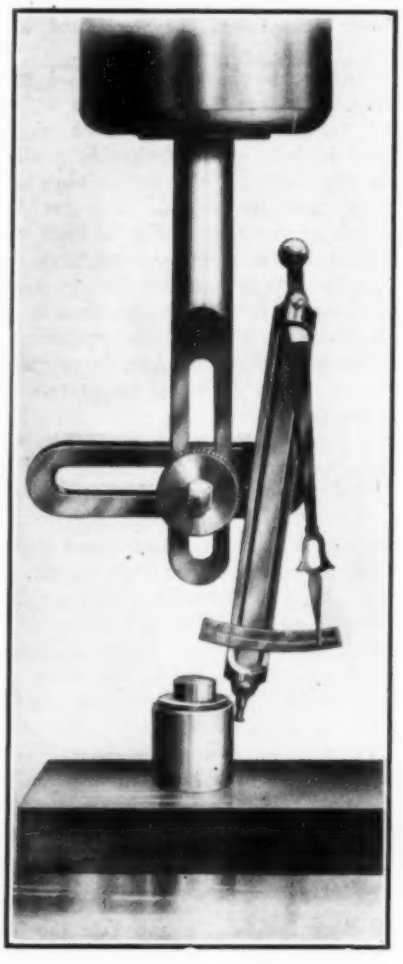


FIG. 11. USING THE INDICATOR IN THE VERTICAL SPINDLE MILLER

For heavy pieces or work which it is undesirable or inconvenient to rotate, accurate boring can be done on a good vertical-spindle milling machine, using the indicator and attachment shown in the half-tone, Fig. 11. The work is clamped on the horizontal platen so that the desired button can be brought under the spindle. If the machine is provided with spring or collet chucks, as several makes of machines are, grip the indicator in the chuck and rotate the spindle by hand, adjusting the indicator until it touches the button; then move the machine platen and work until the button is indicated exactly in line with the spindle. As in this case the indicator revolves round the button and its pointer cannot at all times be seen from the same viewpoint, it may seem as though it would be very difficult to set the button accurately; but this inconvenience is quite compensated for by the ease with which we can move the button and the work to position by the feed screws of the machine without employing the rapping method used on the lathe. Then we have no balancing to bother with; and if a number of buttons are already in position on the work, there is little danger of displacing one. A small mirror may be used in cases where it is otherwise difficult to see the indicator.

For large pieces it is well to have all the holes first drilled approximately correct, leaving only boring to be done on the miller. In such a case the buttons must be of sufficiently large diameter to cover the holes; they may be held on by screws with nuts which fit in small counterbored recesses in the under side of the piece to be bored. When the buttons are removed, these nuts drop into the T-slot in the platen of the miller.

The Use of Disks on the Face Plate

An entirely different method from those described, of spacing holes in master plates is shown in Fig. 12. Take the very simple plate shown at *a* in the four sketches *A, B, C, D,* which plate contains six holes in all, three in each row, 0.5 inch apart, the two rows being also 0.5 inch apart.

The first hole is bored in the usual way on the lathe face plate as at *A*. The piece *b*, shaped like a try square and which has its two inside edges exactly at right angles, is now clamped about the master plate but separated from it by disks of suitable diameter. In this case the disks *c c* at the lower edge of the plate may be, say 0.2 inch diameter. The disk *d* to the right of the plate must be more than 1 inch diameter, say 1.2 inch.

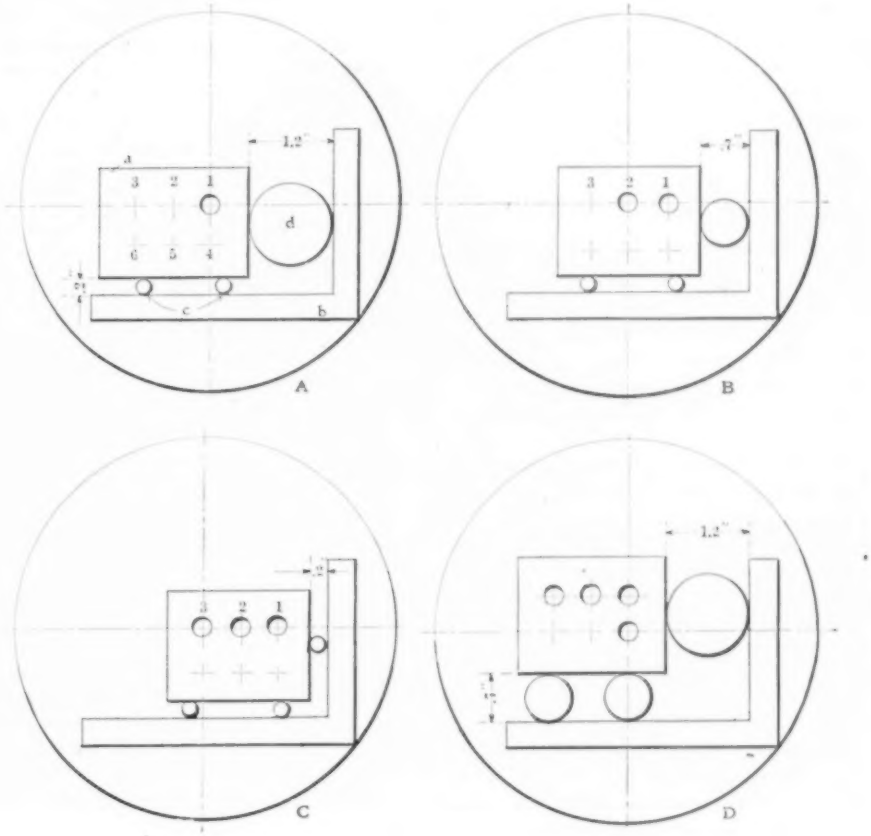


FIG. 12. THE USE OF DISKS FOR SETTING MASTER PLATES FOR BORING

The straps holding the master plate are now loosened and the plate moved forward until it comes in contact with a disk 0.7 inch diameter, that is the plate is moved forward 0.5 inch in a straight line and in this position is shown at *B*. The master plate is now clamped to the face plate and hole 2 bored. Then the plate is again loosened and moved forward another 0.5 inch or until it touches a disk 0.2 inch diameter as at *C*. When hole 3 is bored the disks *c c* are removed and re-

placed by others 0.7 inch diameter, thus raising the master plate 0.5 inch as indicated at *D*. The operations described are repeated for holes 4, 5 and 6.

For this simple job we will need seven accurately ground disks, three 0.2 inch diameter, three 0.7 inch diameter and one 1.2 inch diameter. Instead of disks small parallel blocks can be employed but disks being much easier ground on the bench lathe are generally used.

This method appeals to many people as being simple, quick and accurate. It certainly is a very quick method after the disks have been made and possesses the advantage that should one hole be spoiled or made too large all the holes can readily be rebored. Sometimes a very small amount can be rebored from all the holes without altering the adjustment of the boring tool.

Except on small work and where the holes are very close together this method in the writer's opinion does not equal the button method in accuracy, and as to range of usefulness there can hardly be any comparison of the two methods.

Expansion and Contraction of Carbon Steel in Hardening

By Ethan Viall.

It is extremely difficult for one not a toolmaker, to whom the use of a micrometer is almost second nature, to realize the manner and amount which steel will change in size in the hardening.

On some classes of work, we might spend a lifetime hardening carbon steel and never have occasion to note accurately any material change in the shape other than that occasioned by warping.

Where the tool and hardening rooms are two distinct departments, as they are in some places (though they certainly should not be to obtain the best results), it is seldom that the hardeners know anything of the allowances made by the toolmakers. The hardeners they know are expected to obtain the temper ordered with as little warping of the piece as possible, and any further requirements are not asked. It is for this reason that many hardeners insist that steel will not swell in hardening, but no toolmaker of any experience ever makes such an assertion.

The action of steel is varied and peculiar; even the most experienced toolmaker sometimes finds himself at fault. Two pieces of steel from the same bar may vary so much under as near the same treatment as humanity can give it that one is sometimes tempted to give up in despair; but one generally "cusses" a little or much as the case may be and tries again.

A rule found in many treatises on steel, but which the old toolmaker knows has as many variations as letters, is this: "Ordinary carbon steels will expand when hardened at from 700 to 780 degrees Centigrade; from 780 to 800 degrees they neither expand nor contract, while over 800 degrees Centigrade they contract."

Manganese or silicon in excess also makes a great deal of difference in the action of steel in the hardening bath.

A writer in the American Machinist, a short time ago in criticizing an article of mine, made the assertion that *no* steel would expand in hardening and said my statement that it did was absurd and apt to mislead beginners. While the writer was probably sincere in his statement, he was most emphatically mistaken.

A number of years ago every tap used in the nut-tapping machines of E. T. Harris & Co., Chicago, passed through my hands and was thoroughly inspected both before and after hardening. For three years there were not a dozen taps used that I did not use the micrometer and thread gage on.

These taps were in size ¼, 9/32, 5/16, ⅜, 7/16, ½ inch, and the threads were from 14 to 30, the nuts tapped being used mostly in bicycle work. The two most common sizes were 5/16-24 thread and ⅜-24 thread. Jessop cast steel was used exclusively for them, and rods a size larger than the finished tap were turned down to the required size. Drill rod was not used. It was ordinary mill run, *unannealed* cast-steel rod coming in lengths of from 8 to 12 or 14 feet.

The flutes cut in the taps were cut with what is known as a "stocking" cutter, and it left a round-bottomed straight-sided groove. In making a ⅜-24-thread tap, the blanks were finished two thousandths (0.002) under size.

Now don't gasp at the amount; it is large; but this is fact, not theory. The taps were hardened in clear water after heating to a cherry red in a coal forge and were drawn on a hot plate. Little attention was paid to the change in length, as the nuts were so thin as to give no trouble, but the tap always showed a shortening when the thread gage was applied.

The amount of swelling in proportion to the diameter of the tap decreased as the size increased, and *vice versa*. The length of the thread portion of the tap also made a difference. On all our nut-machine taps from ¼ to ½ this length was 2 inches, including the taper, which was ¾ inch.

All my later experience has but confirmed my first observation in regard to taps made of unannealed Jessop cast steel. Other steels have given practically the same results. However, thoroughly annealed steel will not swell as much nor will a finished tap made of unannealed steel which is annealed before hardening; but in making taps or dies I always prefer using steel as hard as can be worked, as it gives a much smoother thread and is not so apt to tear or chatter. Many times I have heard toolmakers complain of inability to cut a smooth thread when the sole cause was that the steel used was too soft to cut smoothly.

Now leaving taps, let us next take up plugs, rings and bushings.

Plugs that are longer than their diameter by at least one-half will almost invariably swell in diameter and shorten in length if hardened so that they cannot be touched with a file. When the length and diameter are nearly the same, my experience has been that both the length and diameter increases. In all cases of this kind where accurate measurement was taken, the steel used was either Jessop, Colonial or Howe.

In rings and bushings the steel was Jessop, Howe or Sanderson and a few of Columbia. On heavy thick rings, where the hole was considerably smaller than the diameter, the hole always decreased and the outside diameter increased, while on long thin bushings the hole and outside diameter both decreased quite often, though on this class of work measurement is difficult on account of distortion. As a rule, little attention is paid to it by the toolmaker, as grinding and lapping are depended on to remedy any inaccuracy.

No comparison can be made between carbon tool steel and iron in their action, as some have attempted, for the reason that there is so much difference in this composition even if one can shrink either a steel or an iron collar onto a shaft.

The article by John Phin, on page 541, interested me more than any similar article has for a long time. With the taking of the specific gravity of the steel, no errors due to distortion need be considered as in all other methods. That steel does usually increase in size is positively shown, though of course the direction of the greatest increase is not shown. His tests on brass are also perfectly in line with practical experience.

A clock has been installed in the observatory of the Case School of Applied Science, Cleveland, O., which is so nearly perfect that it has attracted the attention of the Smithsonian Institution at Washington. Tests have proved that the mechanism is so accurate that the clock will not vary more than fifteen one thousandths of a second from the exact time in twenty-four hours. This is considered to be nearly as steady and reliable as the sun itself.

From Kingston, Canada, comes the report that the highest class of American-made printing presses and machinery are used in the newspaper offices of that city and district, and, in fact, throughout most of Ontario. They are found to give better satisfaction and run more smoothly than other foreign makes.

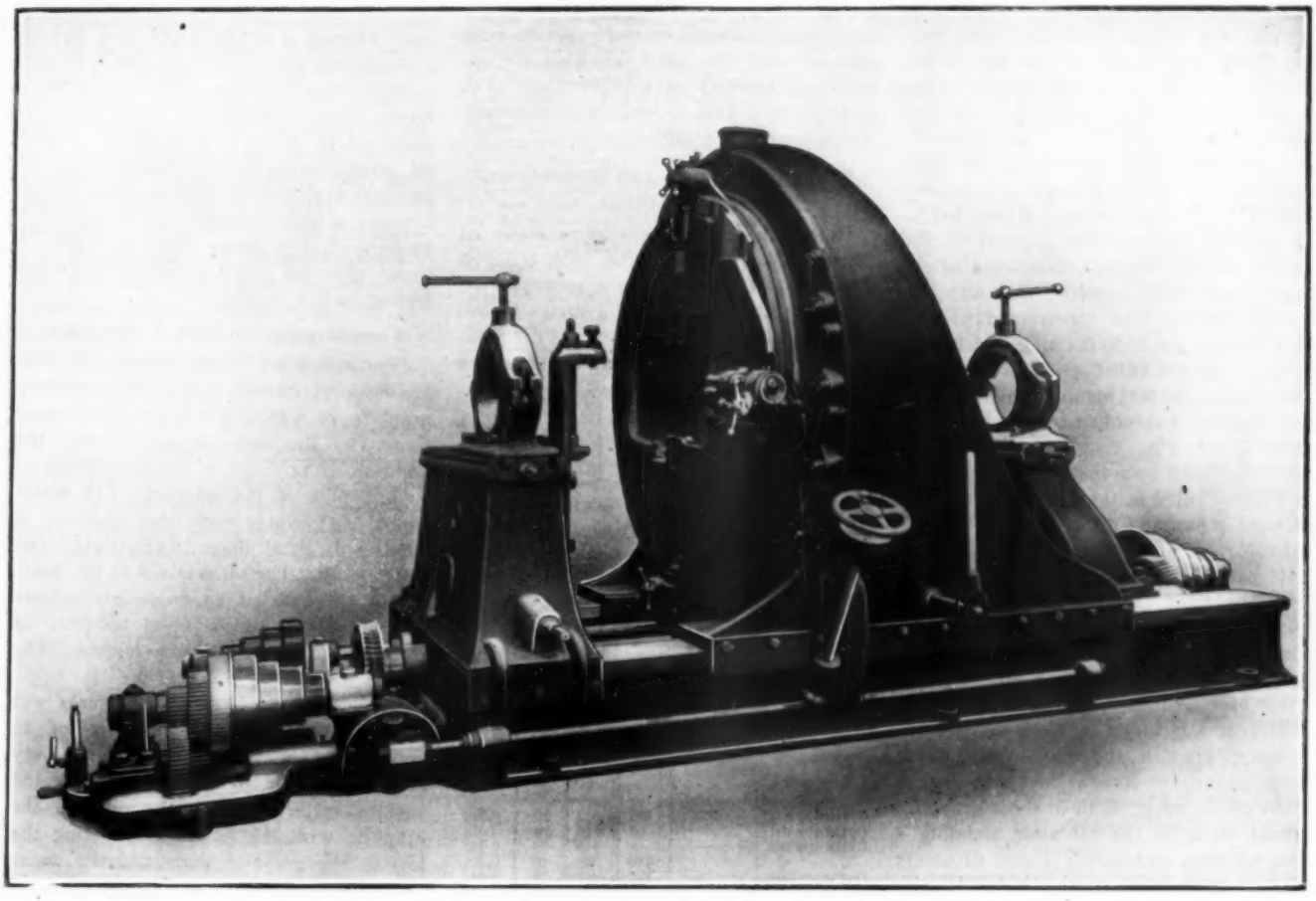
A Novel Crank-pin Turning Machine

By Frank C. Perkins

The crank-pin turning apparatus built in accordance with Capitaine's patent adapts itself for efficiently dealing with crank-shafts having the largest size crank-pins in use. In addition to shafts with one or more cranks, by employing a special clamping arrangement, shafts with end pins may also be handled. The apparatus is capable not only of roughing out the crank-pins in the shortest possible time, but also of turning and finishing them to a limit of one- or two-hundredths millimeter, this being with high-speed steel. Furthermore, the inner and outer surface of the crank-arms may be worked up with the machine.

The mode of working is such that the crank-shaft itself remains at rest, being held close to the crank-pin being operated on. The tools rotate in carriages having a long guide. By this method of working, the pins are turned very true and the capacity of the machine is far greater than that of an ordinary turning lathe, since there is no springing of the shaft.

A circular frame well stiffened by webs is mounted on the powerful bed. This is made to traverse, the feed being positive and adjustable by means of strips and an adjusting contrivance. Jamming or running askew is rendered impossible by the long guide and the manner of effecting the travel. The bed further carries a steady rest with collapsible bearing, in which the crank-shaft to be worked on is firmly clamped. The crank-pin is given an exactly central position in relation to the circular frame, the bearings being adjustable according to the particular radius of the crank. The adjustment of this bearing is brought about by a screw which has a micrometer adjustment and can be read off to tenths of a millimeter. The steady rest is furnished with clamping tongs for clamping in the crank-arms.



A NOVEL CRANK-PIN TURNING MACHINE

The drive is from a countershaft at the left, having a three-stepped cone in the case of the three smallest machines built and four-stepped in the case of all other sizes. The power is transmitted by a large spur-wheel gear on to a conically adjustable ring of best steel mounted in a wide bronze bushing in the circular frame, thus imparting a rotative action to the ring and the tool disk attached to it. Tool slides are mounted in long, double-webbed guides on the tool disk, holding the working tool firmly and in such a manner as to prevent vibration of any kind. They are so dimensioned that the narrowest crank-pins can be worked, only one exchange of tool being necessary. They have further an automatic feed by means of the usual star wheel and knock-offs, these being spring mounted as shown. They are also adjustable by hand. For turning crank-arms a removable slide rest is arranged on the revolving tool carriage.

The feed screw for the circular frame lies exactly in the middle of the bed, and the bronze nut engaging it is of extra length so that it moves in very evenly. The circular frame has a self-acting feed on the bed, this being effected by cone pulleys with suitable wheel gears having twelve different speeds ranging from 0.2 to 5 millimeters per revolution of the tool carriage. The circular frame is arranged for hand adjustment, and in the case of the two largest sizes an arrangement for a rapid power travel is furnished. The automatic longitudinal feed can be thrown out and reversed from the operator's stand, without necessitating his glance being turned from the work.

The whole machine is extremely powerful, all wheels being milled and the guide nuts particularly long and of best phosphor bronze. The bearings are easily accessible for lubricating and are protected against dust and dirt by swivel caps.

This interesting machine is made by Breur, Schumacher & Co., Kalk, Germany.

Experiments with Graphite Lubrication

Graphite Improves the Lubricating Qualities of Most Oils, the Poorer Grades More Than the Better. Results of Many Tests

BY C. H. BENJAMIN*

The experiments described in this paper I made during the spring of 1907. The machine used for the purpose was a "Cornell" oil-testing machine, as designed by Prof. R. C. Carpenter and built by the Olsen Company, of Philadelphia. The journal, on which the tests were made, was 3.75 inches in diameter and 3.5 inches long; the material was steel. The box or bearing was of cast iron lined with babbitt metal and rested on the top of the journal covering about 140 degrees of the circumference; the remainder of the journal was exposed to the air. The lubrication was effected by an oil cup dropping the oil into a trough cast at one side of the bearing, whence it was led by an oil hole and suitable grooves to the surface of the bearing. For some of the experiments with graphite and water, a special bearing was constructed of cast iron without the babbitt lining and having a cavity for the introduction of steam; in this way a constant temperature of about 210 degrees Fahrenheit could be maintained; see Fig. 1. The temperatures were measured by a thermometer inserted in a hole drilled in the metal of the bearing and containing oil.

In November, 1906, I had made some tests with Acheson graphite, comparing it with the flake graphite prepared by the Dixon Company. The graphites were used dry, as a paste with oil, and as a 5 or 10 per cent. mixture with ordinary machine oil. In these experiments no great difference was found between the two varieties of graphite, the results being sometimes slightly in favor of one and then in favor of the other. Both of these graphites would settle in the oil after standing a few minutes, and it was found necessary to feed them in at regular intervals with a squirt can, agitating the mixture thoroughly each time before applying. The objections commonly urged against the so called "amorphous" graphite as a lubricant certainly did not apply in this case, since the Acheson graphite was pure and seemed to find its place on the surface of the bearing as readily as the flake variety.

My first acquaintance with deflocculated graphite was in January, 1907, when I was called to the factory of the Acheson Company, at Niagara Falls, to see some tests of this new form of graphite. Small quantities of the ordinary powdered graphite and of the new variety were put in test tubes with water and thoroughly shaken. The tubes were placed in a rack side by side, when the ordinary graphite promptly proceeded to settle to the bottom, as is its usual habit. The deflocculated graphite remained in suspension and showed no signs of suspension. I have since tested such a mixture and find that in several months' time the precipitation is slight. Mr. Acheson then prepared a cone of filter paper and poured the mixture through, when practically all of the graphite went through with the water, showing the remarkable fineness of the particles. The addition of a drop or two of acid at once precipitated the graphite.

Tests of Graphite and Water with Cylinder Oil

In March and April, 1907, a series of tests was made on the deflocculated graphite and water, using a steam-heated bearing. The journal had a surface speed of about 240 feet per minute, and the pressures did not exceed 32 pounds per square inch of projected area. Comparison was made with a high grade of cylinder oil with the results given in Table 1.

FIG. 1. ARRANGEMENT OF STEAM-JACKETED BEARING AND THERMOMETER

Lubricant.	Duration Minutes.	Average Temperature.	Load Per Sq. In.	Average Coefficient of Friction.
Cylinder oil.....	185	213	16	0.026
Cylinder oil.....	60	212	24	0.019
Cylinder oil.....	45	215	32	0.025
Deflocculated graphite and water.	110	208	16	0.031
	140	213	16	0.045
	30	204	24	0.055
	120	98	16	0.037

TABLE 1. COMPARISON OF DEFLOCCULATED GRAPHITE AND WATER WITH CYLINDER OIL.

The deflocculated graphite in these tests showed a coefficient of friction about 50 per cent. greater than the cylinder oil. This was to be expected because of the small quantity of graphite carried in suspension.

One important fact was at once apparent, that the graphite effectually prevented oxidation of the journal. This and the further fact that the mixture flowed freely with the ordinary oil-cup feed suggested the probability that it would be a cheap and efficient lubricant for the cylinders of steam engines. The good effect of graphite, when introduced in small quantities to engine cylinders, has been recognized for some time, and the suspension of graphite in water furnishes a ready means of so introducing it.

Another series of tests was made in April, 1907, using a mixture containing one-half of one per cent. of the graphite suspended in water on the same journal. In these tests a babbitt-lined bearing was used without a steam jacket, and having a projected area of about eight square inches. In connection with these experiments, trial was made of a soapy or emulsified oil of German manufacture. This oil, while having the same appearance as ordinary machine oil, will mix with water, forming a milky solution of an unctuous quality. A few drops of it in a gill of water give the latter a decidedly greasy feeling to the touch.

Comparisons of Five Lubricants

Comparison was made between the following lubricants: (1) Deflocculated graphite in water, a 0.5 per cent. solution; (2) the same as above with the addition of 12 drops of the emulsified oil to one pint of the mixture; (3) water alone; (4) water with the addition of emulsified oil, as above; (5) Atlantic red machine oil. The oil was fed to the bearing at the rate of 10 drops per minute and the other lubricants at the rate of from 30 to 40 drops per minute. The results are given in Table 2.

A comparison of the above figures will show that at the low pressure of 25 pounds per square inch there is not very much difference in the friction for the various materials used, the oil and the graphite with the emulsion standing the lowest, the graphite alone and the water alone being about the same. The thinner lubricants do not seem to be able to stand much increase of pressure above 30 pounds per square inch without an increase of friction and heat. The oil, on account of its higher viscosity, gains rather than loses by the higher pressure and temperatures. The graphite used would be suitable for countershaft and light line-shaft bearings where the load is small or medium. There is a gradual improvement of bearing noticeable as some of the graphite is deposited on the surfaces, filling up the inequalities.

Tests for Corrosion

The use of the emulsified oil was to determine its effect on the rusting or corrosive qualities of the mixture. In order to test this more directly, equal quantities of the mixtures numbered (1) to (4)

*Dean, Schools of Engineering, Purdue University.

were placed in beakers and similar pieces of polished steel immersed in them. At the expiration of a week's time, the steel in the clear water was red with rust and flakes of iron oxide covered the bottom of the glass. The steel in the oil and water mixture was very slightly oxidized, while the pieces of steel in the two graphite mixtures were entirely free from corrosion. Deflocculated graphite and water can be successfully used as a lubricant for bearings under light pressure and without any danger from oxidation. While the friction is greater than that of oil, the lower cost of the graphite and water would probably make it a more economical lubricant in some situations.

In May, 1907, Mr. Acheson succeeded in transferring the graphite from water to oil, so as to suspend it in the latter. When the mixture is properly made, the suspension is practically indefinite in duration, the graphite showing no disposition to settle in a period of weeks or months. In May and June, 1907, some eighteen or twenty tests were made by the writer, using different oils and different percentages of graphite. Usually, one run was made with the oil alone, and then, several similar runs with percentages of graphite varying from one-sixth to one. Especial pains were taken to have the conditions as to pressure, speed and the application of the lubricant exactly similar in the different runs of a series. A babbitted bearing was used, similar to the one previously described.

Lubricant.	Duration, Minutes.	Final Temperature Fahrenheit.	Load Per Square Inch, Pounds.	Final Coefficient of Friction.	Temperature of Room Fahrenheit.
Deflocculated graphite	175	86	25.0	0.035	68
Deflocculated graphite	60	92	31.0	0.036	68
Deflocculated graphite	60	101	37.5	0.0467	68
Graphite emulsified	120	83	25.0	0.0275	69
Graphite emulsified	20	84	31.0	0.026	69
Graphite emulsified	20	84	37.5	0.025	69
Graphite emulsified	60	96	43.75	0.0386	69
Water alone	120	79	25.0	0.0325	67
Water alone	60	89	31.0	0.044	67
Water alone	60	107	37.5	0.065	67
Water emulsified	120	86	25.0	0.035	69
Water emulsified	60	89	31.0	0.036	69
Water emulsified	30	92	37.5	0.035	69
Water emulsified	30	95	43.75	0.0372	69
Deflocculated graphite No. 2	120	86	25.0	0.030	69
Deflocculated graphite No. 2	60	96	31.0	0.046	69
Deflocculated graphite No. 2	30	100	37.5	0.045	69
Deflocculated graphite No. 2	30	106	43.75	0.0543	69
Machine oil	120	83	25.0	0.025	66
Machine oil	30	84	31.0	0.026	66
Machine oil	30	86	37.5	0.025	66
Machine oil	30	87	43.75	0.020	66
Machine oil	30	91	50.0	0.021	66

TABLE 2. RESULTS OF TESTS OF SEVERAL LUBRICANTS.

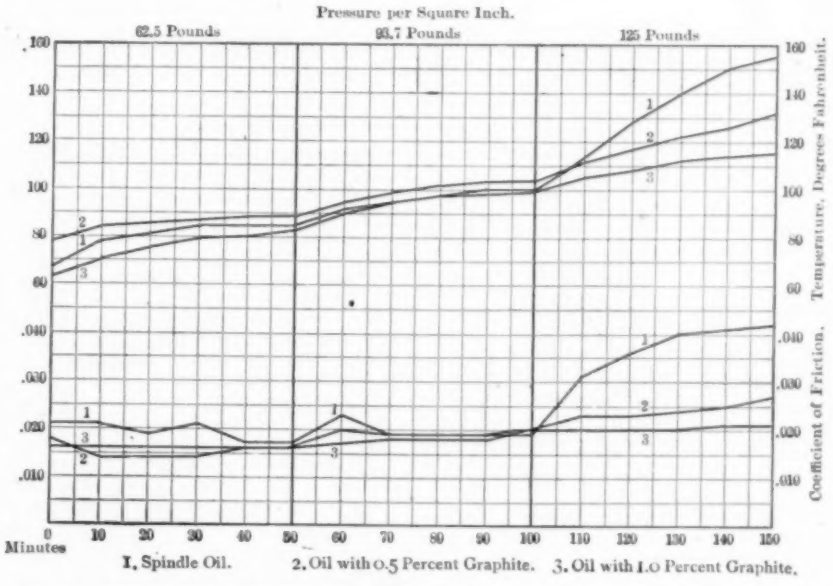


FIG. 2. GRAPHIC LOG OF TESTS ON A "SPINDLE" OIL WITH AND WITHOUT GRAPHITE

Graphite and Oil

Table 3 is a condensed report of the first set of tests on a so called "spindle" oil furnished by Mr. Acheson. Fig. 2 is the graphic log of the test.

At the lower pressure, there did not appear to be much difference in the results, but the application of the 125 pounds per square inch at once showed the advantage of the graphite mixtures. On June 1, tests were made of the same mixtures with a constant load of 125 pounds per square inch, the supply of lubricant being shut off after running two hours. The values of f at the end of this time for the oil alone and the two mixtures were 0.040, 0.022 and 0.020 respectively; and the temperatures, 158, 121 and 144 degrees respectively. The oil alone ran only about 20 minutes after the supply was shut off, while the run was continued over an hour with each of the others. The action of the latter was much smoother than that of the oil, as evidenced by the steadiness of the beam of the machine. The graphic log is given in Fig. 3.

Influence of Rate of Feed

Fig. 4 shows graphically the results of two tests to determine the influence of the rate of feed of the lubricant on the friction and temperature of the bearing. Starting with an average rate of 22 drops of oil per minute, the rate was gradually reduced until it was only one drop per minute, and finally at the end of two hours, the flow was stopped altogether. After stopping the feed, the bearing with oil alone soon showed signs of distress, the friction changing violently and suddenly. The journal with oil and graphite lubrication ran smoothly for an hour and a half after the supply was stopped, and at the end of that time showed no sign of failure. An examination of the bearing after the test was stopped showed a glaze of graphite on the babbitt metal. The pressure was about 60 pounds per square inch, and the surface speed of the journal about 240 feet per minute.

Time in Minutes.	Load Pounds Per Square Inch.	Final Coefficient of Friction.			Final Temperature Degrees Fahrenheit.		
		Oil Alone.	With 0.5 Per Cent. Graphite.	With 1 Per Cent. Graphite.	Oil Alone.	With 0.5 Per Cent. Graphite.	With 1 Per Cent. Graphite.
50	62.5	0.017	0.016	0.016	84	88	82
50	93.75	0.019	0.020	0.020	100	103	99
59	125.0	0.042	0.027	0.021	155	132	115

TABLE 3. RESULTS OF A TEST ON A DEFLOCCULATED GRAPHITE "SPINDLE" OIL.

Fig. 5 shows the values of f obtained in comparing Renown engine oil alone with the same oil carrying 0.16 and 0.32 per cent. of graphite, with a surface speed of about 450 feet per minute and a pressure of 60 pounds per square inch. These were distinctly endurance runs, as the journal was run in each test for nearly seven hours without any supply of lubricant. The Renown oil is a high grade of engine oil, but the effect of the small quantities of graphite used can be detected without difficulty. That of the 0.16 per cent. is slight, the average coefficient during the first two hours being reduced from 0.018 to 0.016, or about 10 per cent. At the end of two hours' run, the value of f is 0.017 for the oil alone and 0.013 for the oil with 0.32 per cent. graphite, a reduction of nearly 25 per cent. The average friction during the last hour or so of the

run is 0.022 for the oil alone and 0.018 for the oil with 0.32 per cent. graphite, a reduction of 20 per cent. For lack of time none of the lubricants was tested to the point of breaking down. In this set of tests the journal had a surface speed of about 450 feet per minute and a pressure per square inch of about 60 pounds. The lubricant was fed at the rate of eight drops per minute.

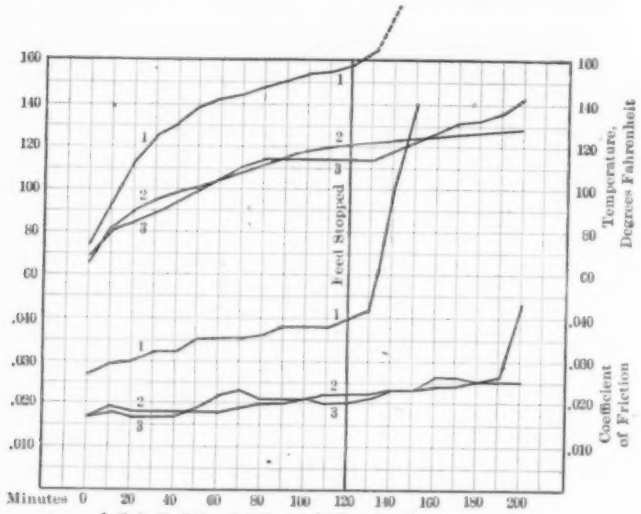
On July 6 comparative tests were made of Union thread-cutting oil No. 1, with and without graphite. The same bearing was used as in the last series, with a surface speed of 400 feet per minute and an oil feed of two or three drops per minute for one hour. The supply was then stopped and the test continued with gradually increasing loads until the lubricant failed. Fig. 6 gives the log of the tests graphically.

On July 8 similar tests were run on summer lubricating oil No. 38, a lighter oil than the preceding and inferior in lubricating qualities. Fig. 6 also gives the graphic log of this test.

The graphite has a beneficial effect on both oils in reducing the friction and increasing the endurance, but this effect is more marked in the case of the poorer oil. Consid[illegible] the time at the end of the first hour ju[illegible] efore the oil was shut off. With the firs[illegible] il the frictions are 0.027 and 0.022, a [illegible] ng of about one-fifth; with the secon[illegible] l, the figures are 0.032 and 0.025, a sa[illegible] of about one-fourth. In both cases t[illegible] endurance of the oil alone ended with a pressure of 140 pounds per square inch, while the mixture with the graphite carried 160 pounds. The two runs on each oil were made the same day, with the conditions exactly the same; the difference in results can be attributed only to the quantity of graphite present. It is probable that one-third of one per cent. is about as small a quantity of graphite as it will pay to use. On the other hand, it is doubtful if more than one per cent. is advisable on account of the thickening of the lubricant and the tendency to clog the oil holes and grooves.

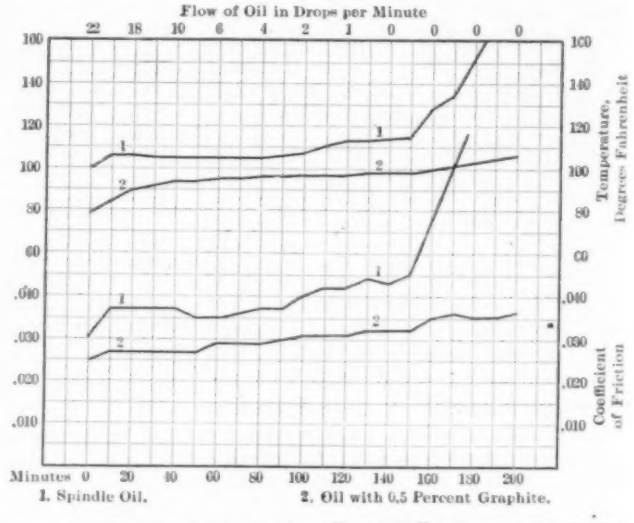
Conclusions

Experiments with various mixtures of graphite and water have shown that one-half of one per cent. of graphite will prevent corrosion, improve the lubricating qualities and gradually improve the surface of the bearing by leaving on it a film of graphite. Engineers generally have recognized the advantages of using graphite as a lubricant in conjunction with oil, as it reduces the friction and prolongs the life of the journal. The action of the graphite in gradually filling up the minute irregularities in the bearing, and producing a smooth film having a low coefficient of friction, is well understood. There have always been mechanical difficulties in introducing and spreading the graphite, which have hindered its use to a considerable extent. The permanent suspension



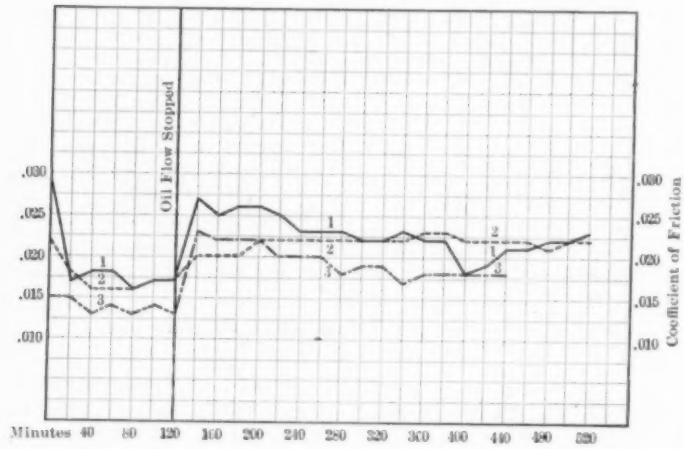
1. Spindle Oil. 2. Oil with 0.5 Percent Graphite. 3. Oil with 1.0 Percent Graphite.

FIG. 3. GRAPHIC LOG OF TESTS ON A "SPINDLE" OIL WITH AND WITHOUT GRAPHITE AND AN INTERRUPTED FEED


Flow of Oil in Drops per Minute
22 18 10 6 4 2 1 0 0 0 0
Temperature, Degrees Fahrenheit
Coefficient of Friction
Minutes 0 20 40 60 80 100 120 140 160 180 200

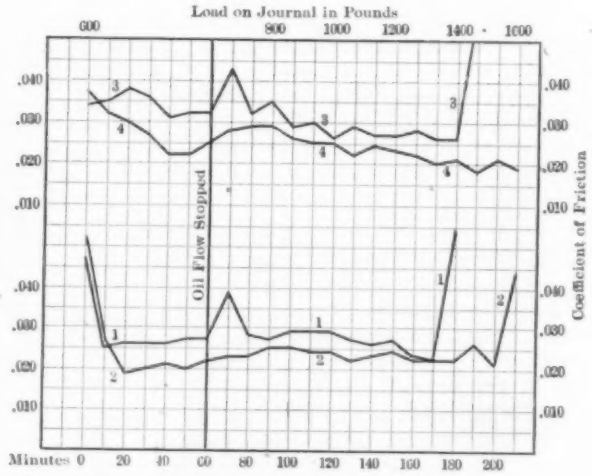
1. Spindle Oil. 2. Oil with 0.5 Percent Graphite.

FIG. 4. GRAPHIC LOG OF TESTS ON A "SPINDLE" OIL WITH AND WITHOUT GRAPHITE AND A VARYING RATE OF FEED



1. Engine Oil. 2. Oil with 0.016 Percent Graphite. 3. Oil with 0.032 Percent Graphite.

FIG. 5. GRAPHIC LOG OF TESTS ON AN ENGINE OIL WITH AND WITHOUT GRAPHITE


Load on Journal in Pounds
600 800 1000 1200 1400 1600
Oil Flow Stopped
Coefficient of Friction
Minutes 0 20 40 60 80 100 120 140 160 180 200

1. Union Thread Cutting Oil. 2. Oil with 0.35 Percent Graphite. 3. Summer Lubricating Oil. 4. Oil with 0.35 Percent Graphite.

FIG. 6. GRAPHIC LOG OF TESTS ON THREAD-CUTTING AND LUBRICATING OILS WITH AND WITHOUT GRAPHITE

of graphite in oil or water overcomes this difficulty and makes it possible to introduce small quantities of graphite without any change in the methods of oiling.

The peculiar union of the deflocculated graphite with the oil has somewhat the same effect as an increase in its carbon content and gives a cheap oil the same lubricating qualities as the more expensive varieties. There is here a wide field for investigation. The use of such a lubricant for bearings under widely different conditions as to speed pressure and temperature, the oiling of the cylinders of air compressors and steam and gas engines, the application of the new mixtures to the splash lubrication of automobiles and launch engines—all these questions may be profitably studied by scientists and engineers.

A Method of Broaching Tang Slots in Spindles

By John Edgar

The ordinary method of producing the tang slot is to drill and mill a slot, clear through the spindle of the proper width and length, into which the shank tang may be inserted. The slot is of such a shape that it prevents the shank from turning in its seat. Fig. 1 shows the usual method.

The sketch shows that, as far as the driving of the shank is concerned, the amount of metal removed is more than really necessary. The slot on either side of the hole is of no use for that purpose. But in spindles that have no central hole into which a punch rod may be inserted to force out the shank, the through slot is necessary for the drift to force out the shank. In drilling machines the front or lower end of the spindle is of such a length that the drift or tang slot comes outside of the bearing, so that it may be readily reached.

In the case of the milling machine and any other machine in which the spindle is subjected to great lateral strains, the spindle bearing is brought out as close to the nose of the spindle as conditions will allow. It is obvious that in such a case the slot would come in or near the center of the bearing and would cause trouble from the latter by allowing chips and grit to enter the bearing through the open slot. In machines so constructed it is the usual process to plug up the slot with babbitt or other metal, thus closing the aperture.

The usual process of drilling and milling out the slot is a tedious operation; and when done, is worse than useless, because the metal removed has to be replaced by some substitute. It appears to be worse than a waste of valuable time, and at the same time materially weakens the torsional strength of the spindle. Various methods have been employed in obtaining the desired slot, the two commonly employed being to drill and chip out the web or to use a small end mill and mill the slots through. It was to overcome these undesirable features that this broaching process was developed.

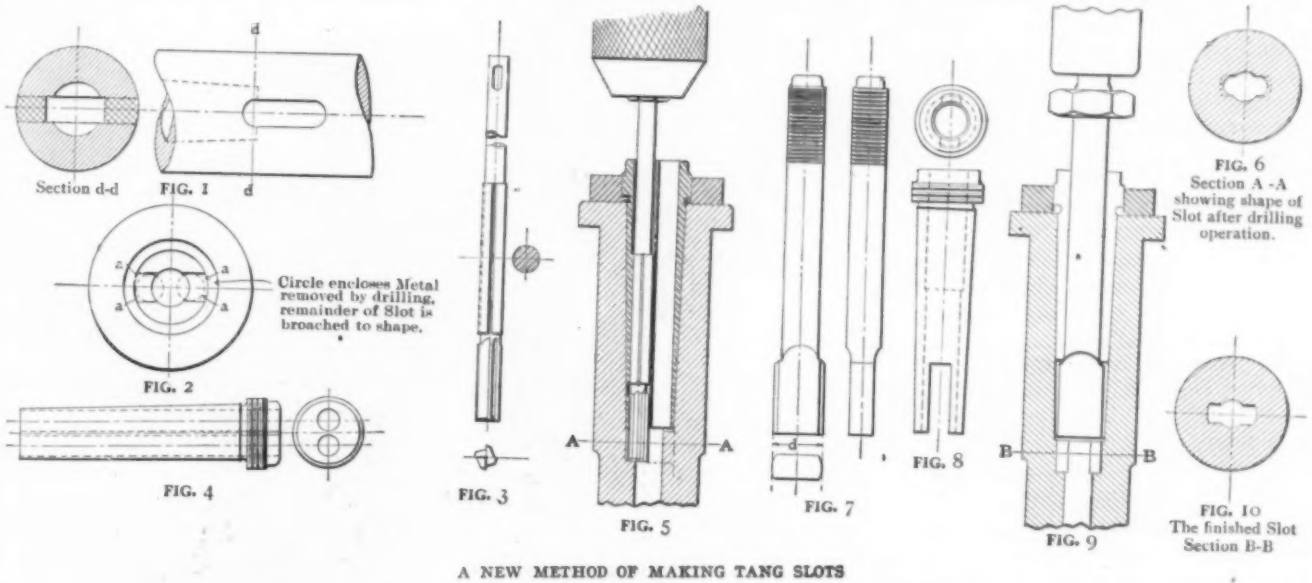
Fig. 2 represents what would be seen on looking into the mouth of the taper hole in the spindle of a milling-machine spindle. It will be observed that the amount of metal actually needed to be removed is small and lies on each side of the through hole. The greater portion of this metal can be removed by sinking a mill or drill into the bottom of the hole, as represented by the broken-line circle. It will be seen that the amount of metal left is small and is merely that in the corners *A*. It was decided that this could be removed by broaching.

It is obvious that some means must be at hand for supporting both drills and broaches. Fig. 3 shows the drill used. This is a four-lip or fluted mill and has a shank that is the same size as that over the teeth forming a sufficient means for support. Fig. 4 shows the bushing or drill support, which is provided with two holes. This bushing is made of tool steel, hardened and ground; the holes are lapped to size. The holes are diametrically opposite each other, of a distance apart consistent with their size and such that the holes will not be too close to the edge of the bushing at the smaller end, which would cause them to crack in hardening. The drills or cutters are made the same in diameter as the finished width of the slot, leaving nothing on the side for the broach to remove. The large end of the bushing is provided with a threaded portion onto which a nut is screwed and used for extracting the bushing from the spindle.

Fig. 5 shows the drill and bushing in use, and a better conception of the amount of material removed by the drill is here obtainable. The dot and dash line shows what the finished slot will be. The drill should be run in an eighth to a quarter of an inch deeper than the required depth of the slot, as it is difficult to broach to a bottom and no harm is done so long as the slot is correct in shape to the depth at which the tang enters. The figure also shows one side of the slot untouched. The grooves in the side of the drill are for the purpose of admitting lubrication. The chips drop into the through hole, as this drilling operation is preferably done on an upright drill.

The bushing is provided with a mark under the threaded head which is transferred to the spindle after the former is driven home into position. It is used to locate the broach support bushing in a proper relation as regards the drilled holes. Fig. 6 shows the shape of the slot when the drilling operation is done, and is a section taken through *A A* of Fig. 5. The dotted lines in the former figure show the desired finished shape, and give another opportunity to observe the amount of stock to be removed by the broaching operation.

The broach shown in Fig. 7, is made of



A NEW METHOD OF MAKING TANG SLOTS

the best quality of punch steel and hardened to a light straw, giving a hard, tough tool. The shank is ground to size and the upper end is threaded to accommodate a drawing-out nut. The broaches are made in sets. The first broach can cut 0.05 inch on a side, but after the second the diameter *d* should not vary more than 0.03, the last one being even less. By trying to remove too much with any single broach, it may be bent or damaged in other ways.

Fig. 8 shows the supporting bushing for the broaches, one bushing being used for the full set. It has to be removed after each has been used. A mark on this bushing, which corresponds with the mark on the drill bushing, is used to locate it in its proper position so as to bring the broach in proper line in each case.

Fig. 9 shows the broaching operation in process. The smaller or first broach is about to be pressed home. For this operation the spindle is placed in an upright position against a suitable support—a vertical V-block—under the ram of a hand or power press. The sketch needs no further explanation. Fig. 10 shows a section through *BB*, Fig. 9, and shows the shape of the finished slot.

This method is a time saver; as the troublesome job of plugging up a hole is obviated, it is to be recommended where the tang slot is so located that the through slot would come within the limits of the spindle bearing. As already mentioned, it is obvious that the through slot weakens the spindle, and the broaching method would be advantageous where a solid spindle, that is, one without the through hole, used and other methods than that of using a drift wedge are adopted for removing the taper shank.

To give credit where it belongs, I am indebted to W. E. Gray, of Hyde Park, Mass., for this ingenious method of obtaining the tang slot.

Report comes from the American consulate at Glauchau that a master weaver has put into successful operation a patented invention by means of which hand looms may be driven by electric power, a description of which follows:

It is so contrived that all of the parts of the old loom may be used except the "frame." The loom so made over answers all of the requirements of a power loom, and even works much more quietly, since the blow is given by a spring which is compressed by an eccentric. The power for such a loom is said to be inexpensive, the cost of the electricity consumed amounting to about 28 cents per week. The operation of the loom is so simple that it can be directed by a child. The invention is one that promises to be of great value to this region, as of late years there have been hundreds of looms crowded almost or entirely out of operation by the more rapid and labor-saving power loom.

Universal Cam-cutting Machine

The accompanying illustrations show a new cam-cutting machine, the design of J. J. Keating and F. C. Marquardt located at 19 Warren Place, New Haven, Conn., which, as the illustrations show, is adapted to the making of both face and periphery cams as well as levers with cam faces and disks with cam-shaped slots. Fig. 1 shows the machine as set up for milling face cams, while Fig. 2 shows the arrangement for periphery cams.

Milling Face Cams

In Fig. 1 the master cam or former is

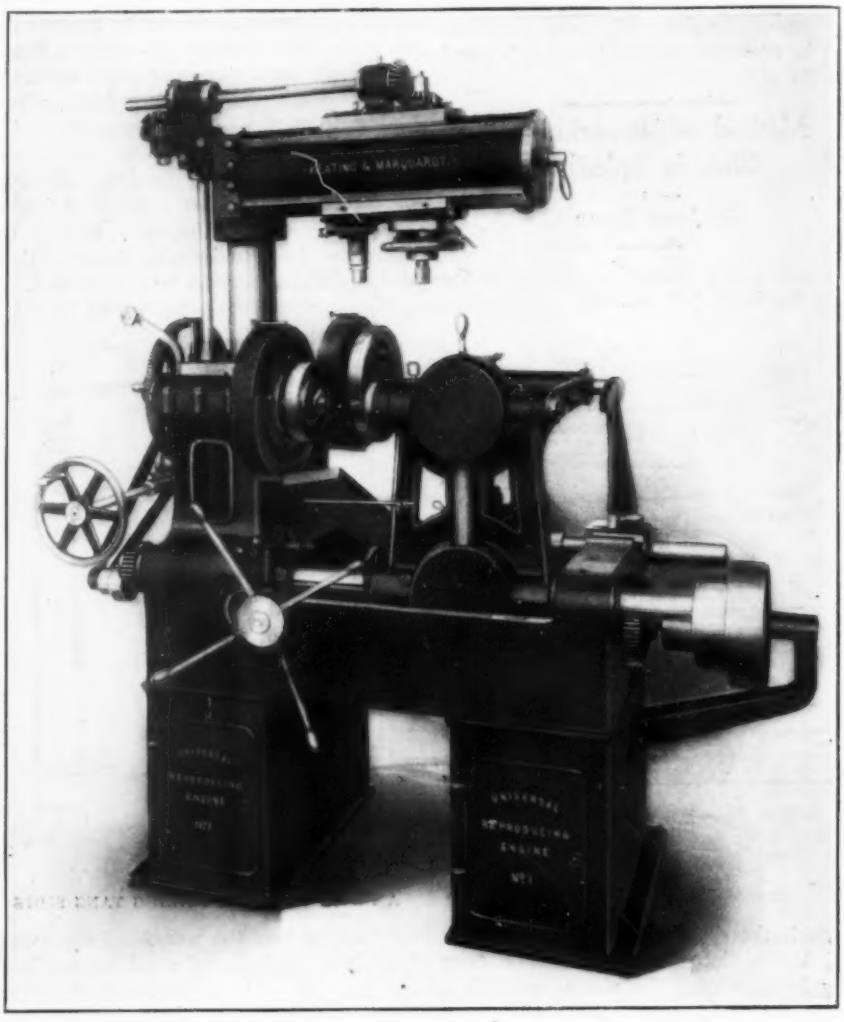


FIG. 1. CUTTING A FACE CAM

located on the rear spindle, while the cam blank is located on the spindle nearest the observer. The milling cutter is in plain view, as is the rear end of the pin carrying the guide roller, these members being supported in the upper ends of two swinging arms which are pinned to sliding guide bars at their lower ends and connected together by radius links at their upper ends, the swinging arms and links forming three sides of a swinging parallelogram. The milling-cutter spindle is driven by a pair of miter gears within the circular box at the upper end of the swinging arm. A vertical shaft runs down through the boss in the middle of this arm and connects by a corresponding pair of bevel gears within the lower circular box to a horizontal driving shaft which extends to the left through the hollow guide bar on which the arm is supported and at its left-hand end has a gear by which it is connected to the main driving shaft, of which the cone pulley is seen at the right.

The guide bars have racks upon their lower sides which, engaging with pinions connecting with the pilot wheel in front, permit the swinging parallelogram and the cutter to be adjusted to and from the work, a swinging micrometer stop, which is shown turned up out of the way in Fig. 2, permitting this adjustment to be made with accuracy. During such adjustment of the cutter the guide roller remains in engagement with the groove of the master cam, the roller spindle being stationary and its arm sliding over it. In case of need, however, the roller bar is readily withdrawn by first pulling back the arm at its rear end.

The master cam and blank are supported upon auxiliary face-plate arbors which are recessed at the back and fitted

and bolted to the main face plate, the bolts filling the holes and acting as dowel pins to permit the removal of the supplementary plates and their accurate replacement. The main face plates have spur-gear teeth cut upon their peripheries and are connected by an intermediate pinion. The driving is through the spindle, which, by means of a worm wheel at the outer end of the spindle, carries the blank being cut as shown in the rear view.

The hub of this worm wheel has a square-jaw clutch which may be disengaged and the two spindles be turned by the pilot wheel shown just outside the worm gear in Fig. 3. The worm which mates with this worm gear is driven by bevel gears and cone pulleys, as also shown in Fig. 3; by removing the belt this worm may be turned by the hand wheel, shown in Figs. 1 and 2, for purposes of adjustment when starting the cut or for hand feeding, should that be desired.

Cutting Open Cams

The cam shown in process of being cut in Fig. 1 has a groove for inclosing its roller and thus giving a positive motion in both directions. When cutting open cams intended to have a spring return, or when cutting a grooved cam from a former which has no groove, provision is made for attaching a weight and maintaining contact, as shown in Fig. 3.

Cutting Periphery Cams

When cutting a periphery cam, the parallelogram is folded to the rear, as shown in Fig. 2. The rear spindle is not used, the former and cam blank being

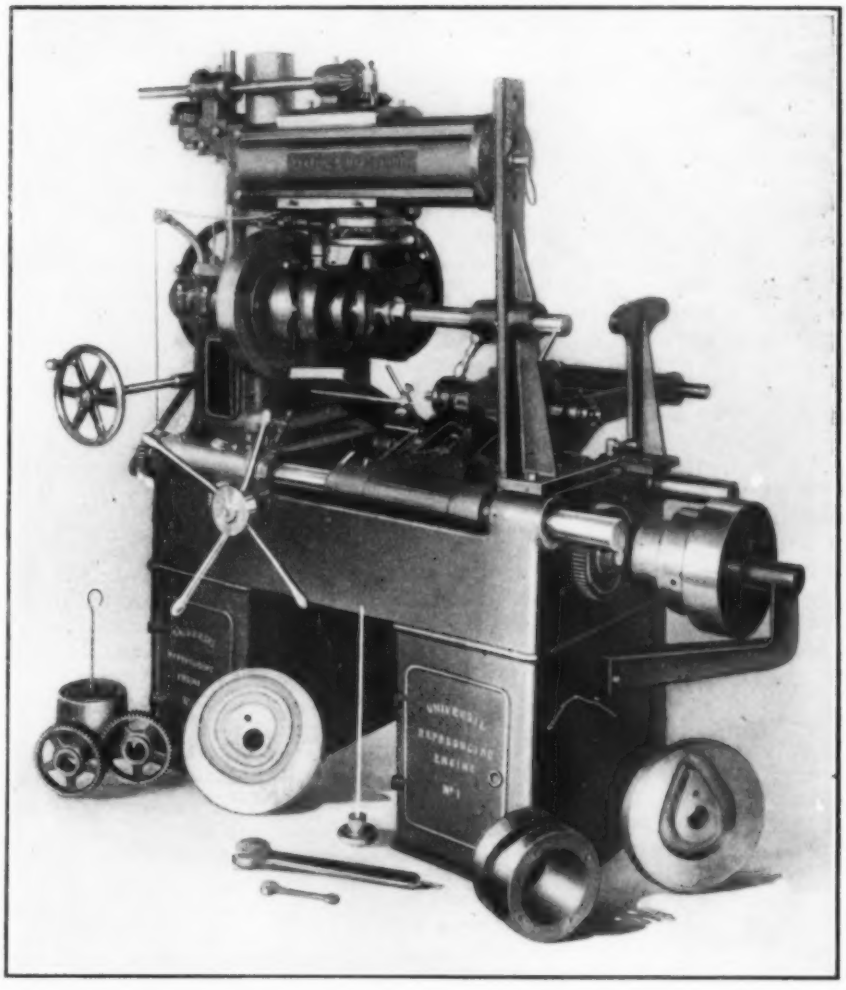


FIG. 2. CUTTING A PERIPHERY CAM

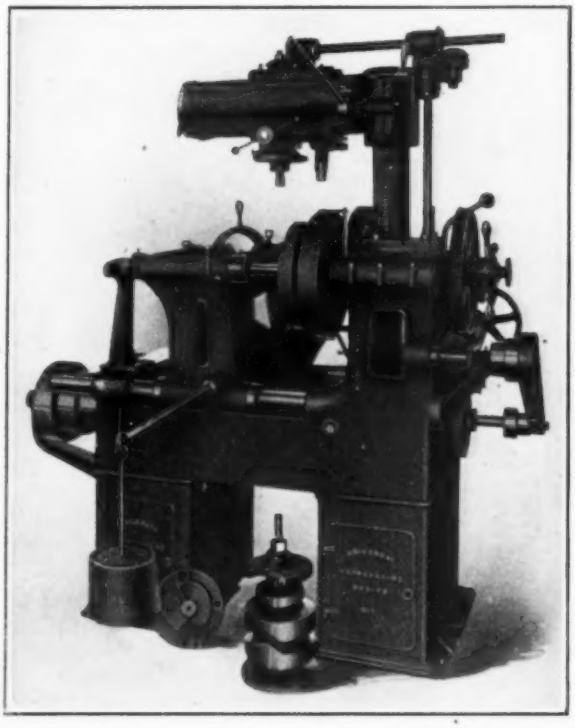


FIG. 3. REAR VIEW OF MACHINE

FIG. 4. SAMPLES OF WORK

carried on the same face-plate arbor, the former being next to the head of the machine. The means of supporting the guide roller and milling cutter is clearly shown in this view, as is the means by which the cutter is driven. In the case shown, the former has a groove giving motion to the cutter slide in both directions, although the cam being cut has no groove and is intended for a spring return. A chain and weight—the former shown in position—are, however, provided by means of which a former which does not embrace the roller may be used in this case, as in the corresponding case of a face cam.

When cutting periphery cams, the hand adjustment of the spindle is especially useful, as such cams usually contain a good portion of an arc which may be finished on the turret lathe when the cam blank has its hub bored and reamed. Being thus finished, the work may be adjusted in the cam-cutting machine so as to begin the cut at the end of the lathe-finished part, and thus save loss of time.

Adjustments for Wear

Special care has been taken to provide for the taking up of all lost motion, which, of course, is important in cam cutting. To this end the gears on the face plates are cut circumferentially in halves with suitable adjustments. In case of lost motion developing between these gears and the connecting pinion, one-half of each gear may be so adjusted that while one-half bears upon the forward sides of the pinion teeth the other half bears upon the rear side, and the lost motion is thus taken up. Again, the worm may be adjusted to and from the worm wheel in order to take up lost motion at that point, and the cutter spindles are provided with bronze tapered sleeves for adjustment.

The machine shown is designed to handle face cams from 2 to 18 inches in diameter and to cut periphery cams having throws of from 2 to 7 inches.

Fig. 4 shows some of the pieces of work that have been produced on the machines.

Fireless stoves, or self-cookers, as they are commonly called, have been in use in Germany for a number of years, but it is now reported by the American consul-general at Berlin that a company there has recently improved upon the apparatus and has produced a fireless stove that not only cooks, but fries and roasts. While only on the market a short time this improved cooker has already proved very popular. Frying and roasting are accomplished in the new cooker by the use of a heated stone. The stone is thoroughly heated in an oven, over gas or any fire, and placed in the cooker with the steak or roast. The box is sealed up and left for an hour or so, as required, then opened, and the food is fully prepared and hot. In the double boxes all three processes may proceed at one time without care or difficulty.

Apprentices and Skilled Workmen in England

By James Vose

The agreement recently signed on behalf of the Engineering Employers' Federation and a number of British trade unions contains a couple of clauses probably more significant than either the signers or the general public have realized. One is to the effect that employers will make reasonable efforts to insure adequate training of apprentices—incidentally, employers and workmen emphasize the importance of suitable theoretical instruction forming a portion of the training—and the other admits the principle of employers endeavoring (in case the introduction of improved machinery leads to rearrangements involving the displacement of, or a reduction in, the number of workmen employed) to utilize the men displaced, either by employing them on the new machines or finding other duties for them.

In former years conditions allowed of apprentices gradually acquiring a working knowledge of their trade, specialization, even when recognized among the journeymen, being waived to a perceptible extent in the case of the boys. At the same time, the men, while deprecating the introduction of apprentices in too large numbers, usually, in a broad if rough and ready way, contrived to impart a sufficient modicum of craftsmanship to the recognized apprentices or juniors to qualify them for membership in the unions. Consequent on the gradual diminution of formal apprenticeship and the increased employment of boys with a view mainly to their exploitation as producers, both men and employers became more lax in their attention to the matter of training, with results not very satisfactory to any of the parties concerned, though the general position has, I fancy, always been more favorable to the production of good every-day workmen than in the United States.

It has often been stated by ill informed or interested parties that trade unions were quite satisfied to enroll men who had put in the orthodox period of apprenticeship, irrespective of their proficiency at their trade; but, speaking broadly, this was seldom the case in the engineering trade. During recent transitional years there may have been some slackness in this respect, the standpoint taken probably being that men who were good enough to be employed during a strike or lockout must equally be good enough for enrolment in the unions as a preventative of such exploitation. It is obvious of course that unions could not afford a large proportion of inefficient membership, as the cost of their maintenance during the frequent non-employment of such men in ordinary times would be too serious a drain on the funds.

It would be too much to expect, for some little time, any very definite results from the efforts now formally promised; but the chief advantage is that such promised efforts are now definitely recorded in black and white, and employers and workmen become jointly responsible for the maintenance of a satisfactory standard of skill. This appears a distinct gain, and points to topics on which more mutual and informal friendly relations could be founded, while honest endeavors on the part of employers to mitigate the harshness often incidentally inflicted, through changed conditions, on men who have practically been constrained to identify themselves with the previous methods, will tend to produce a more cheerful acquiescence in needful changes. Steps in this latter direction might perhaps have been taken earlier but for instances in which skilled men—in the conventional sense—who have been offered the option of working new labor-saving machines have refused on the ground that such work was beneath them and likely to lower their standing when applying for situations in the future. To some extent the last-named objection was well grounded, as it is very much easier—in England, at any rate—to lose craft caste as a result of a temporary concession to expediency than to regain it when desired.

What is Skilled Labor?

Touching on these developments, it would be interesting to compare the impressions, or meanings, conveyed to different individuals by the term "skilled" workman. For instance, a new labor-saving tool is introduced which enables a laborer to perform operations previously intrusted to a "skilled" man. So far, so good. But in a little while the erstwhile laborer develops such proficiency in the manipulation of the new device that, though not recognized as skilled, his services become as necessary to the internal economy of the works as those of the workman he has displaced.

Designers or builders of machines embodying new departures ought, it seems to me, to be very careful how they introduce their productions. In one prominent instance a machine which has now become a standard type of tool was heralded in the advertising columns of this journal as being so simple to manipulate that "anyone with sense enough to come in out of the wet could run one." A little later on in the reading columns—also of this paper—appeared a report of a lecture by the designer of the machine in which he stated that "if really good work was expected from the machine, a discernible modicum of brains must be put into its manipulation," or words to that effect.

The moral of this may be that it is useless attempting to eliminate skill from any craft; all that is accomplished is the atrophy of one sense or intuition and the evolution of another—to command the use of which costs as much.

Features of the Brown & Sharpe Foundry

Interesting Development of Methods of Handling and Storing Material and of Pattern Storage with Safety Always in View

EDITORIAL CORRESPONDENCE

One of the most impressive things about the Brown & Sharpe foundry, in Providence, R. I., is the way in which the natural conditions of hill and hollow, or more properly, side hill and level, have been taken advantage of. A little idea of this is given in Fig. 1, which is a view taken before the sand bins, in the arches below, and the coke house, of concrete construction, were brought within the foundry proper by a roof which puts them all under cover. This roof, or auxiliary building, extends back to the corner of the lot and now includes the pig-iron storage, so that nothing is left exposed to the weather.

The driveway at the lower right-hand corner is now the entrance to the storage building and is reached by an easy grade from the street below, the rise being just the hight of the sand bins. These are of concrete, 10 feet wide by 40 feet long, the top being paved with wooden blocks for the driveway. The sand is dumped into these through the manhole covers shown. Teams with coke go up the street to the right and dump the coke through the roof of the storage building, while pig iron is carried to the rear and piled up ready for use, as shown.

FIG. 1. SAND BINS, IRON AND COKE STORAGE BEFORE BEING HOUSED IN BY EXTENSION FROM FOUNDRY

The great weight sustained by the roof of these bins necessitated a heavy construction; a mixture of one part cement, three parts sand and six parts broken stone was used for this purpose. The roof of the coke pocket is made of 2¾-inch planking supported on steel I-beams. Over this are several courses of pitch-laid felt paper and a top covering of chestnut planks. To make these tight, they were spaced a quarter inch apart and the cracks filled with pitch.

There is also a peculiar feature in connection with the fence or railing which may give a pointer for other places. The lower rail is a heavy channel iron, fastened with the flat side up; it is calculated to get the best of the argument when a heavy truck wheel takes a notion to go over into the sand pits. It is a very rigid construction and has served its purpose well.

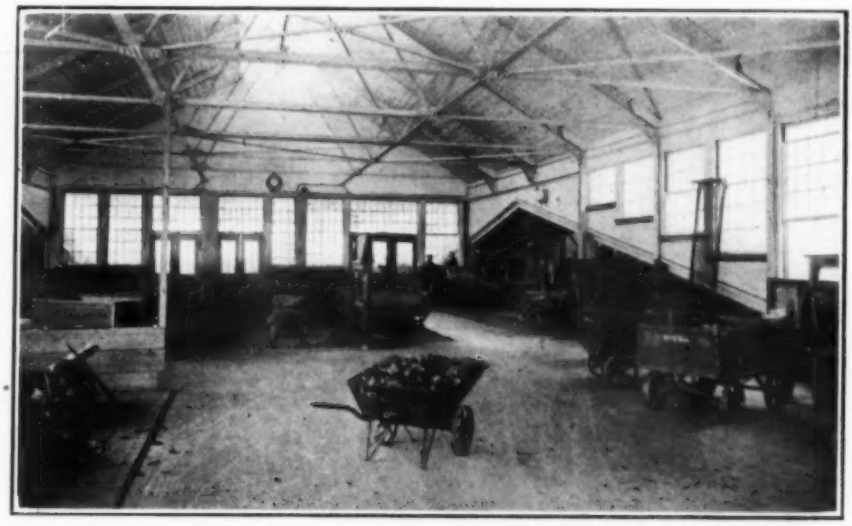


FIG. 2. CHARGING ROOM ON SAME LEVEL AS STORAGE FLOOR

This arrangement stores all the material on the level at which it is to be used and is very convenient as well as economical. Coke and pig iron, each handled in or on its proper truck or barrow, are wheeled from their storage place, across the bridge shown at the left and into the foundry proper, the charging floor being at the other end of the bridge. This is shown in Fig. 2, which gives an idea of the character of the building, the kinds of trucks used, the scrap bin at the left, the weighing scales and above all the ease of charging the cupolas, one being shown in the right-hand corner with charging doors open. Since this view was taken, all the barrows have been equipped with the knuckle guards which were illustrated some months ago.

The sand is on the level with the molding floors, so that it can be easily handled to any desired point by barrow. Fig. 3 gives a general view of the large crane area of the heavy molding floor and shows the smaller cranes running at right angles to this.

Handling the Large Ladles

The heavy crane, a 10-ton Sellers, serves this side of the molding room, handling flasks and molds for the heaviest work, which is always done in this portion. At the right, in about the center, is the pas-

sageway to the light foundry, as will be seen in the plan, Fig. 6. Just to the right of this, up under the crane runway, are the openings for the hot-air system of heating with fan blowers. The usual long galvanized or painted heating pipes are conspicuous by their absence, the hot air finding its way to all parts of the molding floor.

The cupola is in the corner just beyond the passageway, the spout or outlet being visible projecting from the oblong hole in the wall. This is shown in detail in Fig. 4, which also gives an idea of the way in which the large ladles are handled. The cupola discharges directly into the receiving or storage ladle, with its double handle, which is supported by the stands resembling balancing ways. From here the iron goes into the pouring ladle shown in the pit. This allows a steady flow from the cupola, as the receiving bucket can be set up straight to receive all the iron while the pouring ladles are being changed, and then pour its surplus into the next ladle.

As will be seen, the double or sister hook is used in handling the pouring ladle. The 10-ton crane picks it up in this way, and, if the ladle is wanted at some point under the big crane, the handling is a simple matter. If, however, it is needed at some other portion of the molding floor, the big crane takes it to the nearest runway, runs the ladle over to the left, see Fig. 3, the small crane runs out on its track beyond the line of columns, grapples the other side of the double hook and carries the ladle to any point within its range. This saves time, lessens the chance af accident and seems better in every way than setting the ladle down and picking it up again. The heavy ladle is of the geared type for ease in pouring.

FIG. 3. HEAVY MOLDING ROOM SERVED BY ONE 10-TON AND EIGHT LIGHT CRANES

Handling the Light Ladles

The ladles for the light molding floor are handled by the overhead tracks shown in Fig. 5 and in the general plan, Fig. 6. The general appearance of this arrangement, including the method of supporting the tracks, is shown in Fig. 5. The cross-over or switching method can be traced with a little study, being controlled by the chains hanging from the levers above. The counterweight or inverted pendulum shown above the track holds the switch in either position. The worst possible position is shown with the trolley on the short straight piece of track and the cross-over set for use; but even here the trolley cannot be run off, as coming forward it would strike the stop and going backward would be caught by the lower flange of the curved rail. If the trolley were on the end of the continuous rail, it would strike the end of the short piece, so that every contingency seems to be provided for and perfect safety guaranteed.

The Core Room

Those who have painful recollections of the core oven with the fire down under the floor and no way of getting at it except to crawl under a grating with a head room of perhaps three feet, will appreciate the provisions made in this case. Down under the floor is a commodious tunnel or subway, running the whole length of the core-oven space and affording an opportunity for firing and for clearing away ashes in comparative comfort. The plunger elevator, shown near the cupola room in Fig. 6, connects with this and carries anything that may be needed. There are also stairs running down next to the heater and blower room.

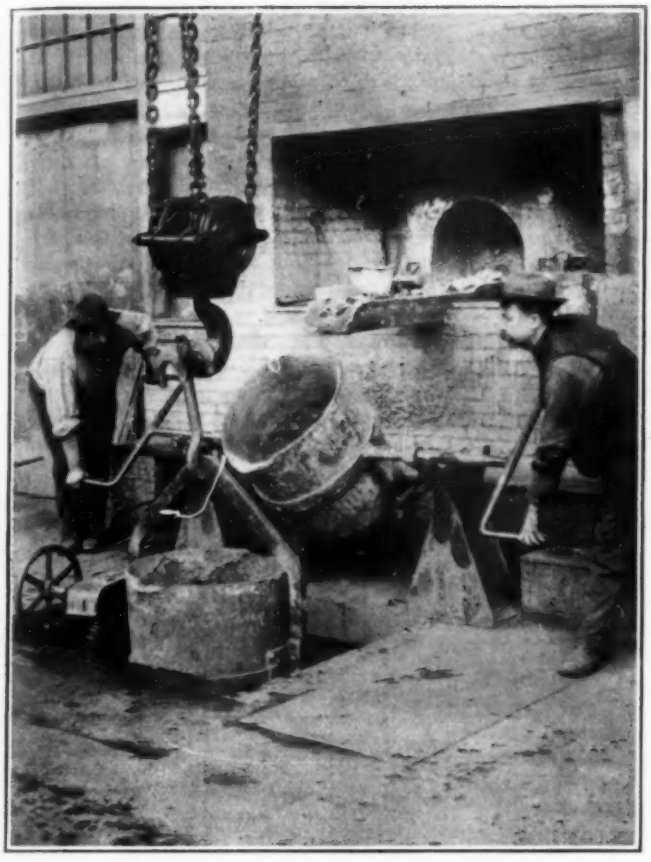


FIG. 4. FILLING THE LARGE LADLE

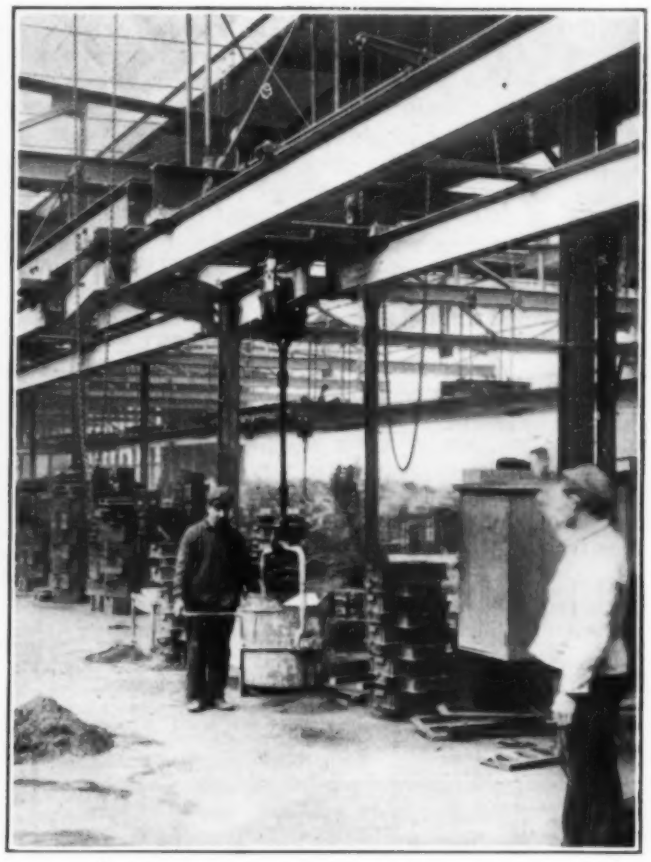


FIG. 5. TROLLEY FOR LIGHT LADLE

Over this tunnel is a grating, as shown in Fig. 7; the various styles of core ovens used are also shown very clearly. For large cores the cars are used to carry them into and out of the ovens, the counterbalanced doors being easily handled.

Beyond this is an oven with the shelves shaped like a generous piece of pie and closing the oven against the escape of heat whether it is open or closed. One objection to this style is that the shelf space is limited as compared with the arrangement of the last oven. This is a four-deck arrangement with an overhead track for the trucks which support the core shelves when out of the oven. The bar which hangs from the truck has a hole for each shelf and can be locked to one or all by the bolt shown in the doors. When drawn all the way out, the oven is closed by the back plate and the shelves are easy of access whether one or all are out at once.

Pattern Storage

The pattern-storage house is novel in several ways, but the feature which first appeals is the low-studded floors, the hight being only 7 feet and accommodating three shelves, as shown in Fig. 8. This is such a contrast from the usual multiplicity of shelves that it strikes one as a waste of room; but when you consider the ease with which every pattern can be seen without climbing all over the shelves or using a step-ladder, the plan impresses you as being a good one to follow.

The arrangement for supporting the shelves is simple and convenient. The arms are made in halves, can be put on or taken off at will and easily adjusted for hight. The corrugated ceiling is supported by similar arms, the ends carrying

FIG. 7. THREE STYLES OF CORE-OVENS

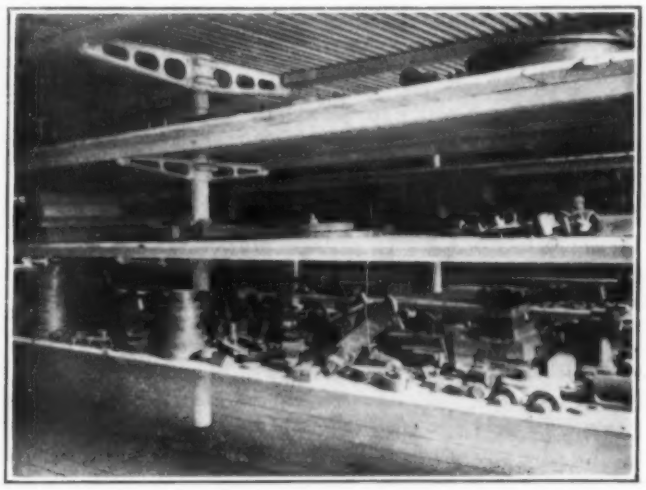


FIG. 8. PATTERN STORAGE SHELVES THAT CAN BE SEEN

the stringers which hold up the ends of the corrugated sheets. The shelves are supported in a similar way, one stringer on each side holding the cross boards.

Even this large foundry is proving of insufficient capacity, and land has been secured for additions which will add largely to the amount of work which can be turned out. F. H. C.

The Bearings of Woodworking Machines

By W. J. Blackmar

A short time ago a writer in the American Machinist stated that very little observation had been taken of the bearings of woodworking machinery, despite the fact that the data and information in regard to them would be exceedingly valuable. As I have had a lifelong experience with woodworking machinery, perhaps what I have to say upon the subject may be of interest.

To the ordinary engineer who is used to metal-working machinery, the high speeds used for woodworking are very often a source of trouble. From four or five hundred revolutions per minute to five or six thousand is a great increase, especially when the revolving parts are subjected to severe strains. Take the ordinary four-cutter molder, for instance, and it becomes apparent to the observer that the upright spindles or arbors have different strains than the horizontal spindles. So little attention is paid to these matters, that only a few of the many woodworking engineers fully understand what are the strains upon these upright spindles.

In the first place a liberal allowance of strength must be given to the structural parts to which the revolving spindle is attached, to allow for improper working. This means that it is possible for the operative to arrange the working parts in such a way that a continuous hammering takes place within the bearing. If there is a sufficient clearance, and a revolving film of oil to deaden the blow, the bearing does not show the hard usage; but if the oil flow is checked in any way, and the metals come into contact, the bearing becomes very hot and the spindle often seizes. With a spindle revolving five thousand revolutions a minute (and in England many workworking machines are speeded higher than this) every part must balance. The nature of the work demands various sizes of cutters upon the spindle, and, unless the operative is exceedingly skilful in weighing and balanc-

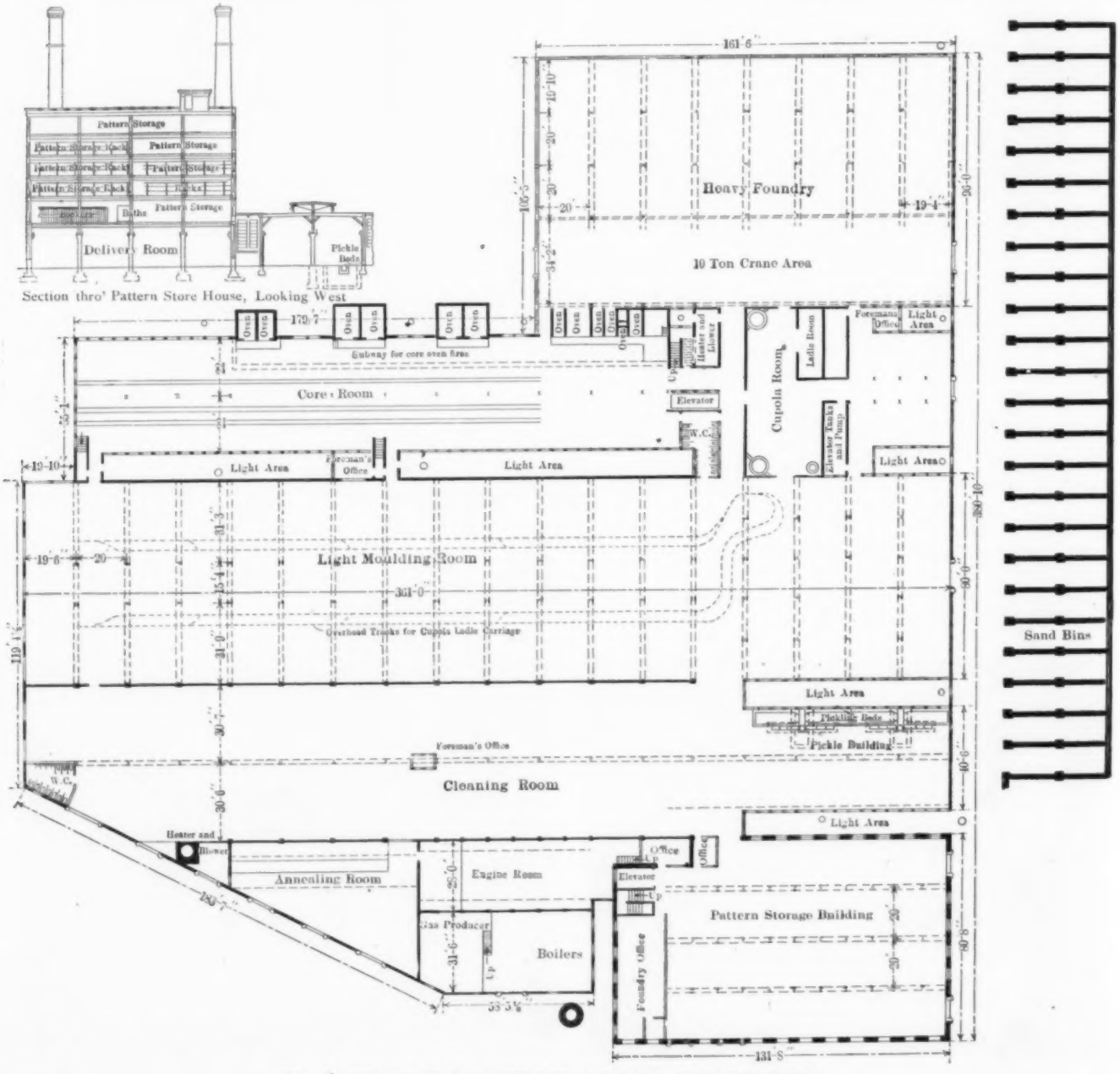


FIG. 6. GENERAL PLAN OF FOUNDRY AND PATTERN STORAGE HOUSE

ing them, the vibration set up by improper balancing is very great. Nor is this the only strain which the upright spindles have to stand. In many cases the cutters used with them take out wood which throws an upward strain upon the cutters. Indeed in some hard woods this is considerable, and, unless the spindle is fastened down, the work suffers and the bearing becomes hot.

In other cases the strain is reversed and extra pressure is put upon the step. It does not amount to a very great deal, still, where the speeds of the revolving parts are excessive, it follows that every extra strain upon the moving parts must be considered and, if possible, allowed for.

Upright-spindle Bearings

Take the bearings of the ordinary upright spindle. They will be found to consist of two bearings and a foot step. The foot step takes the weight of the spindle and acts as a center. The bearings above are used to prevent side play and to keep the spindle in a certain position. All this is well and good and, under certain circumstances, nothing could be better. But, like everything else, various men have various opinions about the bearings above the step. Some men believe in conical bearings, others in the ordinary divided brasses. A few in England use white-metal ones. In the States we have white metal and various patent bearings such as the sectional, etc.

An upright-spindle bearing, when it is made conical, has a tendency to wear unevenly. The ordinary bearing always wears more on the side which takes the strain of the belt, and should it be of white metal and the workman a careless fellow, it suffers considerably and soon wants repairing. Unequal balancing of the cutters causes the white metal to wear at an excessive rate, so that it makes this method an expensive one.

In England there are two distinct opinions as to the best methods of securing the bearings of these upright spindles. One is to put divided sections on the top bearings and a cone bearing at the bottom. The other is to use two cones which can be lowered or raised to take up the wear. What is the result? From considerable observation, the latter method with two cones seems to give the better bearing, if they are properly lubricated. If they are but indifferently lubricated, then the two cones wear unequally on one side, with the result that, when they are lowered to tighten the spindle, they bear unequally upon the revolving parts. The top bearing of a spindle, if of divided brasses, wears most on the side which takes the pull of the belt; in a number of cases many mysterious heatings of these bearings occur because this fact is not taken into account. The outside brass is eased to allow the two brasses to come together, and the cap is again fastened on. This throws the spindle out of line, it bears upon the top inner side of the bottom bearing and against the outside of the top bearing. In many cases these bearings heat under these conditions.

The double conical bearings have this advantage, they invariably keep the spindle in line, and so the only objection against them is the irregular wearing of their parts. In some instances heating is caused in this way. The foot step upon which the spindle is supposed to rest is not tempered sufficiently to withstand the wear of the rapidly revolving spindle. The result is that it wears and the spindle then rests upon the cone, which causes great friction. Theoretically speaking, the spindle should rest upon the foot step and the cone should be in such a position that it is close enough to prevent side play in the spindle, but not close enough to take any bottom strain.

One of the best upright-spindle bearings is put in woodworking machines by a German maker. The bearing is as follows: At the bottom is a step, then a brass cone bearing which rests upon an iron support; over the cone bearing is another, which can be screwed down on top of the lower one. Thus there is a double conical bearing and the spindle is held so that there can be no upward nor downward motion. The top bearing is of the ordinary divided kind. The great advantage of this top cone is to prevent any lifting of the spindle. In some work this is very important, as any play will cause objectional marks upon the finished surface of the wood. The facility with which the top cone can be regulated is the greatest point in its favor. It is rather interesting to note that this spindle was first arranged with the top bearings of white metal. However, it was not successful, wearing too rapidly and thus throwing the spindle out of line. The white metal was taken out and ordinary divided brasses put in. With care, so that the spindle is kept in a perfect alinement and with the foot step keeping it such a distance away from the bottom cone bearing as to allow a film of grease to revolve with the spindle, no spindle can give greater satisfaction. The spindle will run steadily under the greatest strains, and it can be kept exceedingly stiff in its bearings, even at six thousand revolutions per minute if good belts are used. Naturally, with such speeds, heat will be produced, but a low temperature, just enough to expand the metals, is not at all objectionable.

It would take too long to detail the various methods for lubricating upright spindles. One or two of the leading English sawmill engineers have elaborated this feature, making the oil flow upward. In most cases the action of the lubricating part of the spindle is very successful; however, in very dusty work the oil channels become clogged and this necessitates taking apart the spindle and its bearings. From observation I believe that the elaborating of the lubricating parts of these upright spindles is totally unnecessary, as an excellent and simple way of lubricating is by Stauffers lubricators with good grease. The great point to be remembered is that woodworking machinery is subjected to considerable dust, and the method of introducing a grease at the center of the bearing or cone, and forcing it through completely, keeps the dust from entering the bearings. All the used grease collects at the ends of the bearings, and offers an effectual barrier to dust.

Horizontal Bearings

The general idea among English woodworking engineers is that white metal for the horizontal, or for that matter any kind of bearings, is not so good as brass or copper or tin. The American woodworking engineer has quite a different opinion, and at times he puts white metal in his vertical spindle, where it is completely out of place. For horizontal bearings however, white metal is ideal. A machine is of course built to sell, and a manufacturer must study the fads and cranky ideas of his customers. Among the English sawmillers there is a great objection to the introduction of white metal in any of the bearings. I suppose its indifferent results, when put into bearings which received a severe pounding, has founded a prejudice which is dying hard.

My experience with white-metal bearings was upon a German machine. The machine had gone through a fire. The table was afterward planed true and all the bearings replaced with white metal. The result was very satisfactory, and those spindles ran for some years without further attention than taking off a layer of paper between the bearing and the top cap. Comparing white metal with ordinary brass or other such combination of metals the conclusion is that the white metal wears longer, does not heat and in every way is superior to the bearings put into the English machines. The other great advantage is the simplicity with which the metal can be replaced.

In many cases some men will use such tight belts that the spindles cut into the bearings and then amateur attempts are made to put things right. Sometimes one of the bearings will be worn as much as one-fourth of an inch out of line, and then the amateur just closes up the brasses despite the fact that the spindle or arbor is not straight. When the bearing heats, it is put down to some occult reason, such as bad oil, or imperfect grease, and liners are placed in the bearings; then it is good-by to good work in that mill. This would not happen with white metal, for as soon as it was worn to this extent, it would be quicker to cut out the old and reline with new metal than to file and carve away until the bottom and the top meet.

Many English horizontal spindles run in conical bearings, and here again the objection against them holds good. With a workman indifferent as to the well being of his machine, the cones soon lose their conical shape.

Testing the Cutting Quality of Files

An Interesting Testing Machine and Some Results of the Tests Made with Ordinary and Special Steels and Correctly Shaped Teeth

BY EDWARD G. HERBERT*

In an article appearing under the title "Files and File Testing," in Vol. 29, page 203, of the AMERICAN MACHINIST, some account was given of a machine, then newly designed, for testing the qualities of files, and of some curious facts which had been brought to light with the aid of the machine. The file, it may be remembered, is tested by being reciprocated against the end of a specially prepared test bar, supported in a horizontal position on rollers and pressed against the file by means of a weight and chain. The test is continued until the file is worn out and ceases to cut, and the result of the test is automatically recorded in the form of a curve whose ordinates and abscissas represent the number of inches filed off the test bar and the number of strokes made by the file, respectively.

The file-testing and indicating machine as shown by Fig. 1 was invented in England in 1905. Sample files were procured from the principal English and American makers, and tests were made which revealed extraordinary differences of quality. The publication of these results created a sensation in the file trade, and a public file-testing department was established. Testing machines were supplied to a number of file makers, who immediately instituted experiments to ascertain the most efficient form of file tooth and the most suitable quality of steel, with the result that several makers have produced files of an excellence hitherto unapproached.

THE TESTING MACHINE

The file to be tested is held between two headstocks *b b'*, on a reciprocating table *c*. Headstock *b* is provided with a nut and a hollow squared screw *d* for holding the tang of the file and exerting end pressure; it has a slide and a hand wheel *e* whereby the file may be adjusted with its working face parallel to its direction of motion.

The reciprocating motion of the table is obtained from the pulley and main shaft through a pair of bevel wheels, driving a T-slotted crank disk. A crank-pin, whose position in the T-slot can be varied according to the stroke required, carries a slide block of rectangular form, which slides between two vertical bearing surfaces in an extension of the table *c* and serves to drive the latter to and fro. The driving mechanism is inside the box frame of the machine and entirely protected from the filings. The machine is started and stopped by a clutch operated by the handle *f*.

The test bar *g* is supported in a horizontal position on grooved rollers and is pressed against the file by a weight *h* and a chain passing over a pulley and under the bar, to the far end of which it is attached by a hook. The support rollers are grooved to accommodate the chain. The bar is drawn out of contact with the file during the back stroke of the latter, by means of a clutch lever having two hardened jaws embracing the test bar. At the commencement of the back stroke, motion is communicated from a cam on the crank-shaft to the outward end of the clutch lever, causing it to tilt and grip the test bar after the manner of a spanner. A slight continuation of the same motion causes it to draw back the test bar, which is again released at the commencement of the forward or cutting stroke. A spherical weight *j*, with a screwed stem, is supported by the headstock *b* and of course reciprocates with the file. The end of the stem rests against the back of the file, and the inertia of the weight prevents the chattering and jarring of the file which would otherwise take place. The drum *k*, round which is wrapped the diagram sheet of squared paper, is driven from a cam on the crank-shaft through a pawl and ratchet wheel and a train of reducing gears, so as to make one revolution to 120,000 strokes of the file. A pencil *L* is pressed against the paper by a light spring and is carried on a bar *M*, capable of sliding longitudinally in a fixed bearing. A block *N* is attached to the test bar, and a fusee chain is attached to this block; passing over a pulley *O* on the pencil bar, it is held by a fixed terminal *P*. It is evident that as the test bar is filed away it is moved forward by the weight *h*, and a given movement of the test bar causes the pencil to move forward by half that amount. The diagram sheet is graduated in half inches, each of which represents one inch filed off the test bar. The circumference of the drum is 12 inches, and as it revolves under

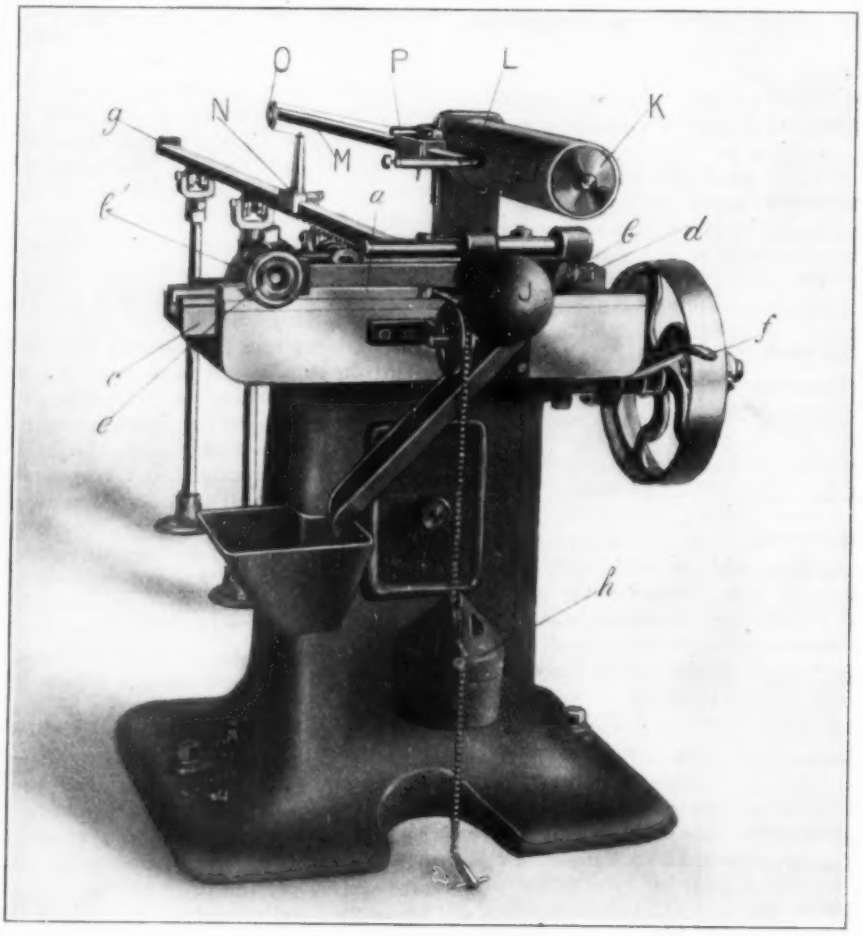


FIG. 1. MACHINE FOR TESTING FILES

*Director, Edward G. Herbert, Ltd., Manchester, Eng.

the pencil each inch represents 10,000 strokes of the file. At the commencement of a test the pencil is set to zero; as the drum revolves and the test bar is filed away, a curve is drawn by the compound motion of the drum and pencil. This curve is a complete picture of the life of the file from the commencement of the test until the file is worn out and ceases to cut, the slope of the curve indicating the sharpness or rate of cutting, while the vertical and horizontal ordinates give

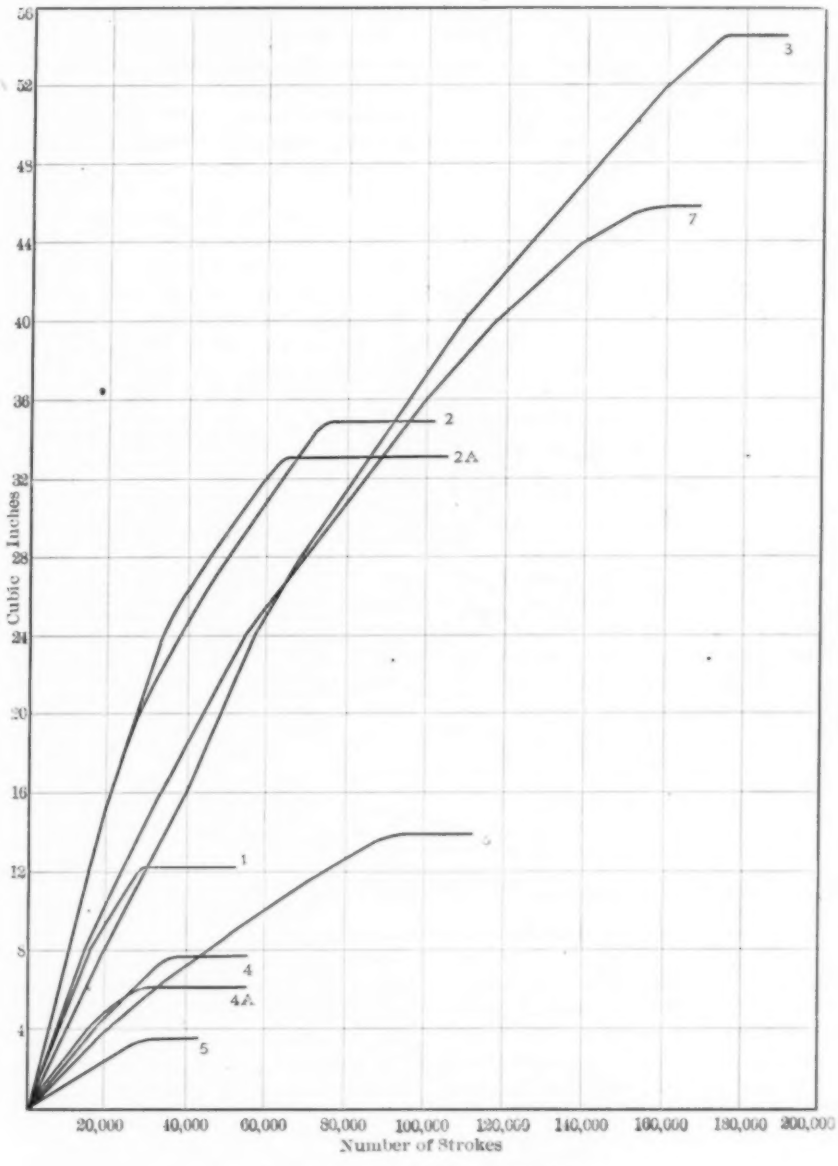


FIG. 2. CHART OF SOME FILE TEST

respectively the total amount of work done by the file and the number of strokes required to do this work and to wear the file out.

The Test Bars

A number of these machines have been in continuous operation at our works and elsewhere since the first article appeared, and it is the purpose of the present article to describe some results which have been obtained since that time.

The machine itself has not been modified in any way, but the test bars have engaged considerable attention. It was found at an early stage that neither tool steel nor machinery steel was suitable material for testing files, because of their tendency to fill up and clog the teeth. Particles of metal would lodge firmly in the file and either stop its cutting action before it was worn out, or more frequently, plough grooves in the soft metal of the test bar, which was thus worn away almost indefinitely under conditions which bore no resemblance to those of actual practice. Cast iron was therefore adopted as the testing material, and this has the advantage of cutting freely without clogging the files; it wears them out in a reasonably short time, and when a file is worn out, it slips over the surface of the iron, which becomes polished and is not worn away by the rubbing of the file. Want of uniformity in the bars gave some trouble, as differences of hardness appeared in bars cast from the same ladle. It was found, however, that all these variations of hardness were removed by annealing the bars, a large number being cast at once and annealed together in a furnace heated by gas, all the conditions being exactly reproduced with each batch; the resulting bars were found to have great uniformity. They were cast considerably larger than the size required, of a specially hard close-grained iron, and then planed down to one inch square.

Comparing Hardness of Bars

The testing machine itself affords a very sensitive method of comparing hardness of materials. A file of good quality is placed in the machine and a test commenced on one of the bars to be compared. The test is stopped when a line an inch or so in length has been drawn on the diagram sheet, the bar is removed and another substituted, the file remaining undisturbed. The test is then continued, and if the bars are of equal hardness, the second part of the curve will be a direct continuation of the first part. If the second bar is harder or softer, there will be a sudden change of slope in the curve, downward or upward as the case may be.

The Chart Curves

In the article already referred to, several diagrams were reproduced, among them that taken from the best bastard cut file, out of the large number by different makers, which had then been tested. This diagram is again reproduced by curve 1, Fig. 2. It filed away 12¼ inches of test bar, and cut when new at the rate of 5 inches per 10,000 strokes. This result was considered exceptionally good at the time when it was obtained. Since that time several file makers have been experimenting with various methods of cutting the files and with steel of good quality, the testing machine being used to ascertain the effect of the various changes in the manufacture. Curves 2 and 2A are taken from the two sides of a file recently produced. This file cut when new at the rate of 8 inches per 10,000 strokes, an advance of no less than 60 per cent. over the former record rate of cutting. This improvement was due to better forming and sharpening of the file teeth. The amount of iron filed away increased from 12¼ to 34½ cubic inches, and, what is not less remarkable in view of previous experience, the curves from the two sides almost exactly coincide. It was pointed out in the former article that most files have a good and a bad side, the former usually doing at least twice as much work as the latter. This has been confirmed by subsequent experience, and most of the ordinary files on the market still show this curious defect; but several makers are now producing files the two sides of which give equal results.

Advance Made

Curves 3 and 7 are further examples of

the extraordinary advance which has been made in durability, the improvement being due in these cases, no doubt, to a special quality of steel, as the file was not a particularly quick-cutting one. The number of cubic inches filed away was 55 and 46, and the number of strokes 175,000 and 160,000. There is reason to believe that this particular file was made specially for testing purposes, as files subsequently supplied by the same maker did not give good results; nevertheless it is a striking example of what can be done with good steel and careful manufacture, and there is no reason to think the limit has been reached, as the records are constantly being broken.

Improvement in Cutting

Curves 4 and 4*A* were taken from a file by a well known maker. Though somewhat dwarfed by the results just referred to, this test does not compare unfavorably with those obtained from files by many makers of first-rate standing, of which curve 5 is an example. Curve 6 shows a file made of good steel and hence durable, but slow cutting owing to poorly shaped teeth. There is still an enormous demand for files which can be sold at "rock bottom" prices, and this demand cannot be, and is not, met by files of high-grade steel. Experience so far gained, however, leads to the conclusion that improvement is to be looked for in the method of cutting quite as much as in the quality of steel, and improvements effected on these lines need not increase the cost of manufacture, rather the reverse. Machinists have long recognized the importance of having all cutting tools ground on specially constructed machines, to standard angles which have been ascertained by careful experiment to give the most efficient cutting action. Economy is thus effected both in the cost of sharpening the tools and in the cost of the work done by them. The file tooth is a cutting tool which works under peculiarly exacting conditions, since it is not rigidly held and cannot be forced through its work as can a lathe or planer tool if blunt or incorrectly ground. Hence correct cutting angles are of special importance in the case of the file tooth, and these can be insured only by the correct grinding of the tool used in cutting the file. Yet it seems to be the usual if not the universal practice to leave the grinding and sharpening of these tools to the judgment of the individual file cutter, or, at best, to that of workmen who, though skilled in the making of such tools, have no better rule for determining their angles than rule of thumb, and no better means of measuring them than the eye.

The abruptness with which the files give out, as shown by the curves, which was referred to in the preceding article, is very surprising.

Much remains to be done in this and in other ways before the file can take its place among the scientifically constructed tools of the modern workshop, but the improvement that has been effected in a comparatively short space of time is highly gratifying.

A Method of Making High-speed Cam Rollers

By L. W. G. Flynt

The cam roller shown in Fig. 1 is used in two extremely high-speeded machines employed in the manufacture of shoes and, as the mechanism to which they are attached is kept in proper relation to the cam by means of springs, the need of lightness is apparent. In one case a stroke of 1/16 inch is required at the rate of 12,000 per minute. The method of manufacture which we have adopted is as follows: Blank rollers are cut from 1 3/16-inch cold-rolled bars in the turret lathe. After drilling and reaming to within 0.003 or 0.004 inch of size for the ¼-inch hole, an allowance of 0.10 inch on each side is left for finishing on the edges of the rim and ends of the hub. They are then taken to the drill press for recessing, where they are held by means of the clamping screw in the device shown at Fig. 3, in a hole that is large enough to insure against the small variations in the size of the stock from which the blanks are cut.

A supporting plug, high enough to provide sufficient clearance for the handle of the clamping device and the operator's hands, is secured in a conveniently arranged hole in the drill-press table by means of a T-handled nut, see Figs. 4 and 5. The cutting tool, Fig. 2, consists of the body *A*, having a taper shank in which grooves are milled for the high-speed steel cutters *B B*. The sleeve *C* in which the set-screws *D D* are provided, secures the cutters and the guide pin *E*. During this recessing operation the roller, not the holder, rests on the supporting plug and, when the first side has been recessed to the depth determined by the stop on the machine, the other side can be presented to the tool by turning over the holder.

After the recessing has been done they are hand reamed and then turned to 1.135 inch diameter in one cut and case-hardened in bone dust. To prepare for grinding, the hole is lapped. This removes any roughness acquired in the hardening process and insures a reasonable uniformity of size. The outside diameter is ground on an ordinary mandrel. The ends are quickly and accurately finished on the stub mandrel shown at Fig. 6, by feeding the face of the wheel into the work.

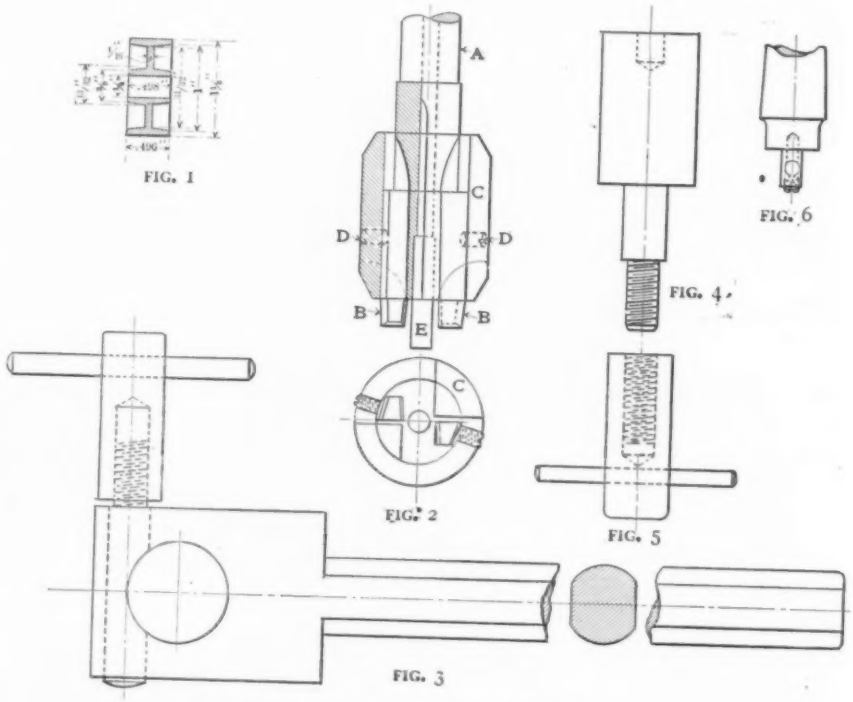


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

TOOLS FOR MAKING HIGH-SPEED CAM ROLLERS

Investigation by the Bureau of Labor shows that for 1906 the increase in wages per hour over 1905 was 4.5 per cent. and the increase in cost of food stuffs 2.9 per cent. so that the purchasing power of an hour's wages was materially increased.

Three-fourths of the general industrial machinery imported into Brazil comes from Great Britain. About six-tenths of the rest comes from Germany, and the balance is divided about equally between the United States and France.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Tricks in Selling Steel

I hear that some of our French acquaintances are up to their old tricks again. Some seven or eight years ago a very nice-appearing man came into my office with some bits of tool steel that would do wonders, so he said. We put a sample into a tool holder and tried it; it came up to steel that we were paying a half more for. We were feeling poor and while we wanted a little steel, we were using almost wholly small sizes in tool holders; so I told him we would take two or three bars (5 feet long, he said) of 5/16-inch square and ⅜-inch square. He had an order slip of his own and he filled out the blanks for just what I wanted and had me sign it. I noticed that there was a line for each size that they made.

In a couple of months we got word from a local bank that they had a draft with bill of lading attached calling for some $150. I was mystified, as I did not connect our order for about $5 worth of steel with a bill of $150; but I soon found that was what it was for. I went to the freight station and found that they had sent a few bars of every size on their list. This agent had simply filled in all the blanks before he sent in his order. Some of our neighbors ordered some of the steel and in all cases their orders had been raised; none so much as ours, however. None of them considered the steel up to the sample.

What I want to suggest is, not that all steel from abroad should be tabooed, but that your own order with a copy at home safely kept is the desirable thing, and also that your order should specify that the steel is to be up to the sample left by the agent; also, that the sample be kept safe. In our own case repeated threats of lawsuits were made, but we never touched the steel nor offered to pay for it. It is not at the freight station now, but I do not know how it got away.

Boston, Mass. ENTROPY.

A Design for Bench Centers to be Built at the Artisan School in Syracuse

One of the problems, in starting the school whose whole aim is to give the boys a chance to learn a trade, has been what to make. So far a fairly good start has been made in getting out the machinists' vise we illustrated some months ago, which has met with a ready sale without coming into competition with other makes of vises, as it sells at a much higher price, being in general as well made and of better design. Other things have been designed and are in process of development, among them a bench center, outlines of which are shown in Fig. 3.

The scheme of this tool differs from the usual sort; first, in holding the stock between spring centers so the piece will rotate freely without shake, and so it may be removed and replaced by springing the head poppet back. Another feature is the using of a graduated feeler in the place of a piece of chalk to indicate whether the prick-punch center is properly located. In centering pieces by the chalk-mark method the center will be located equidistant between the two high points, which may or may not put it where the piece will turn the largest possible; this may be seen by reference to Fig. 1. If located by the points *A* and *B*, the center would be at *C*, and the piece only turn the size shown by the circle *D*; whereas if set by the points *E* and *F*, then the center will be at *H* and it will hold up to the circle *G*.

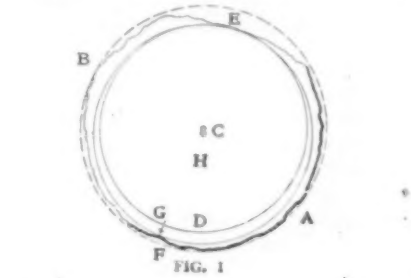


FIG. 1

FIG. 2

THE WORK

In the machine illustrated the pointed feeler is used to indicate the lowest points, and a zero point on the feeler (not shown) indicates by a graduated scale which are the low points; not only where the low points are, but the distance from the center, so that the operator can not only locate the centers properly, but tell just how large the piece will turn. Further, suppose a crooked piece, as shown in Fig. 2, is to be centered. By bringing the three points *H*, *I* and *J* so the index reads the same, that will show that the centers are so located as to get out of the piece all there is in it without straightening.

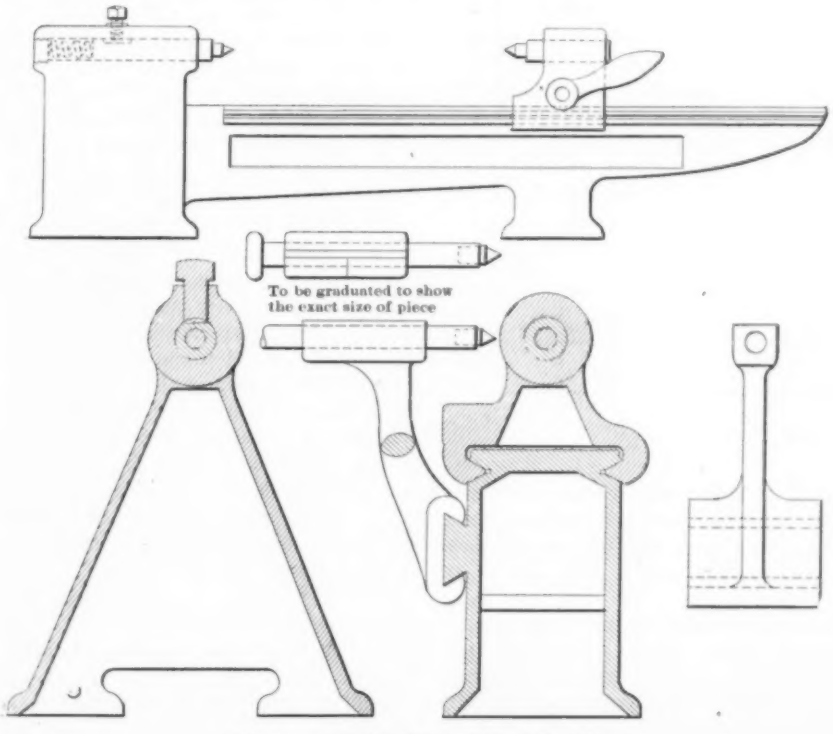


FIG. 3. A BENCH CENTERING MACHINE

It will be noticed that the headstock and legs are cast with the bed, and that the tailstock is secured in a way that makes it practically impossible to injure the ways; so material can be banged about the machine to the operator's delight without doing any harm. The drawing of the machine was made by one of the boys.

To avoid the shop name of apprentices, the school name of scholars, the college name of students or the university name of fellows, those who are there to learn a trade and other things pertaining thereto are simply called "boys." If they can always find new things or things that are better than the regular sort to make, they ought to build up a place where boys will be tumbling over one another to get in. To create a pride in the work is a good thing, and to teach boys to do honest work will go a long way toward making honest men.

Syracuse, N. Y. JOHN E. SWEET.

Adjustable V-Blocks

Having a variety of iron castings frequently coming through our shop in such lots as would warrant putting four or five on a planer at one setting, the method of holding them became one of interest. They were pedestal covers of various sizes and shapes, but always semi-circular. Our task was to plane the joint, the principal requisite being that this surface must not vary more than two or three thousandths from a true plane.

Wooden V-blocks made to our sketch were obtained from the carpenter shop, but these were inaccurate and short lived; so I determined on adjustable V-blocks of steel.

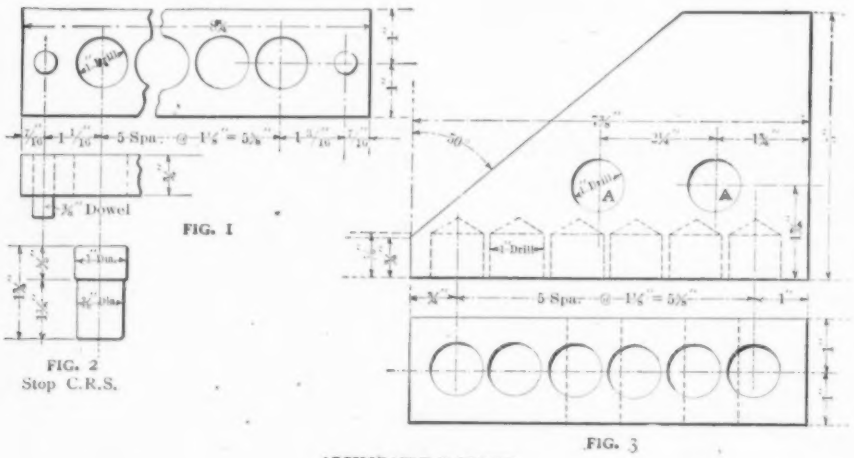


FIG. 1

FIG. 2
Stop C.R.S.

FIG. 3

ADJUSTABLE V-BLOCK

Our planers were 24 and 30 inches between housings, and their platens had ¾- and ⅞-inch holes for stops. I had a lot of stops made from 1-inch cold-rolled steel, with one end turned to fit the holes in the platens, as in Fig. 2. Then we made a jig as in Fig. 1, with which to drill the base of the V's. The V's were planed up from scraps of forged steel and drilled as shown in Fig. 3. With stops in a platen the V-blocks were set over them and secured by clamping at the holes *A;* then a finishing cut was taken on the angular side.

Fig. 4 shows in place in the V-blocks a casting having two different diameters outside, and Fig. 5 shows how the V-blocks adjust themselves by swiveling on the stops, to suit castings which are not parallel. These V-blocks do not need to be fixed by additional stops and shims and packing to keep them from moving on the platen; they may be set farther apart than shown, to accommodate work of larger diameter.

When these V-blocks were put in service, their success was so complete for the work at hand that I submit this account for the benefit of someone who may have similar problems.

Lafayette, Ind. R. H. WADSWORTH.

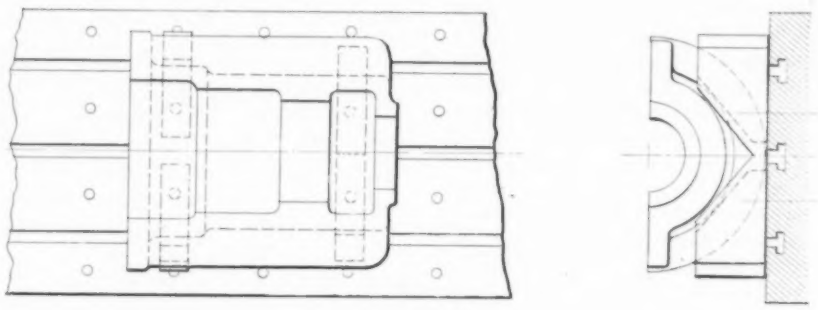


FIG. 4

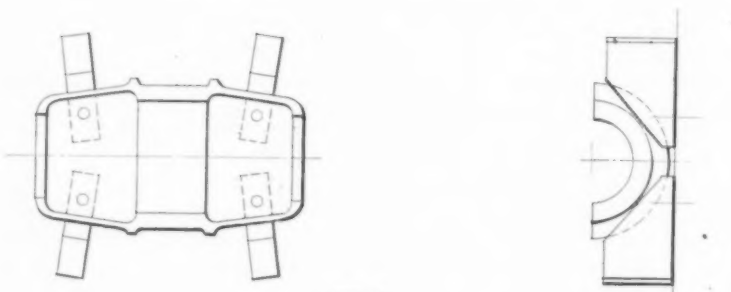


FIG. 5

ADJUSTABLE V-BLOCKS IN USE

Making Low-priced Impression Dies for Hard Rubber

When I read the article, on page 272, on the above subject, and Mr. Dixie's answer on page 415, it carried my memory back to when I was a boy, roaming all over a large hard-rubber factory (now extinct) in New Jersey, watching the men work on different parts until I was driven out by the superintendent, only to return again when he was gone.

This factory made a great deal of hollow ware, such as smoking pipes, lined with some white material resembling plaster of paris, handles for canes and umbrellas, and toy tops. This kind of ware was partly filled with water, sealed, dusted with soapstone and put in a mold made of tin composition; then it was put in the vulcanizer over night under a pressure of steam ranging between 80 and 100 pounds per square inch. As I understood it, the water expanded and drove the rubber out and would fill every little mark and engraving in the mold. These molds were piled up about 18 inches high and put in a strong steel frame with wedges driven in between the molds and frames to withstand the internal pressure. There were hundreds and sometimes thousands of these little molds put in the vulcanizer at night.

This, I suppose, is the reason Mr. Pearce had to have so many dies. This factory made a large quantity of rubber buttons, and it was this process that I thought of when reading the article on page 272.

They punched the soft-rubber blanks

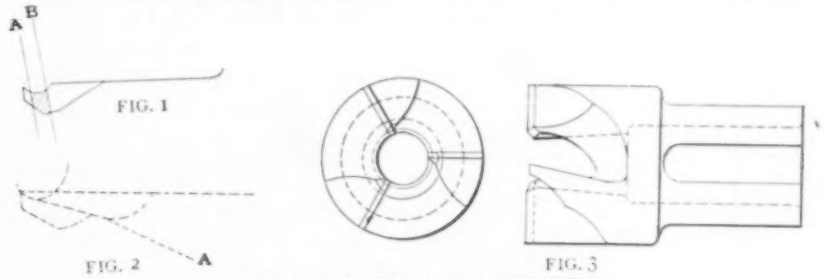
out in a foot press; but I do not know how they prevented their sticking together, except that I remember the sheets of rubber were coated with soapstone. The blanks were laid on sheets of metal resembling lead. It was very pliable; I think it must have been block tin. These were piled up on one another and vulcanized with the other work. Next day the blanks were polished in a tumbling barrel and sent to the press room. In this room each man had a press and a set of 24 steel dies made as Mr. Dixie described. The press was about four feet long and had twelve steel, square-thread screws about one-half inch pitch in a row before the operator. The bed was hollow and had a cold-water circulation under the dies when they were under the screws. The operator would loosen one screw, take the die out, also the button, and step across the passageway to a large stove where he had extra dies and hard-rubber blanks getting hot; placing the cold die on the stove, he returned with a hot one and a blank (which was quite soft and pliable under pressure), placed it under a screw, tightened it and loosened the next one, repeating the performance all day, thereby making hundreds of buttons every day, with about two dozen dies.

It seems to me that this process might be used by Mr. Pearce to good advantage. Perhaps the dies could be made double so as to make two pieces at one squeeze, as they did in some instances with buttons.

Bridgeport, Conn. A. W. BRADLEY.

Hollow Mills for Screw Machines

I read with pleasure the article on automatic screw-machine tools by Conrad, at page 260, but was surprised to note his remarks upon lipping the hollow mill as indicated in Fig. 1 herewith. In the time of flat drills, etc., a lip was given on the point as Conrad suggests; but it was a case of the remedy fitting the crime. When twist drills became standard, good mechanics let well enough alone. Who has not had trouble with the lathe hand grinding the parting tool this same way, because not inclined to follow the clearance along the tool? Of course, like most other things, it will do when in a hurry or for an odd job; but Conrad shows it on a standard tool. When line *A* is reached, the mill will have to be ground away back to *B;* there are four cutting edges to be brought in line, and then the cutting radius has to be applied again. Why not continue the clearance line like *A,* Fig. 2, as this can be done at the same setting when milling clearances? The chip may have a tendency to curl, but it curls into a ball like a clock spring and soon breaks away, it being next to impossible to get a chip the length of the stock unless traveling a very short distance. I have used hollow mills like Fig. 3 for some time and have had the best of results. The clearance is about 10 degrees, and the inside is ground slightly taper, about 1 in 40. I use only three cutting edges. The mills are of high-speed steel and finished all over. I have run these tools over 100 hours without regrinding, removing 7/16 inch of metal at 125 feet per minute with a feed per revolution of 0.007 on open-hearth steel. When a hollow mill needs grinding, it is because the inside edge has worn, and it takes more than a mere grind to bring this out again. The fact that you have to balance all the cutting edges causes some people to declare the hollow mill a failure. Another thing noticed is the absence of a slight bevel as in Fig. 3; this helps to break the chip and leaves the body a good finish and free from scratches.



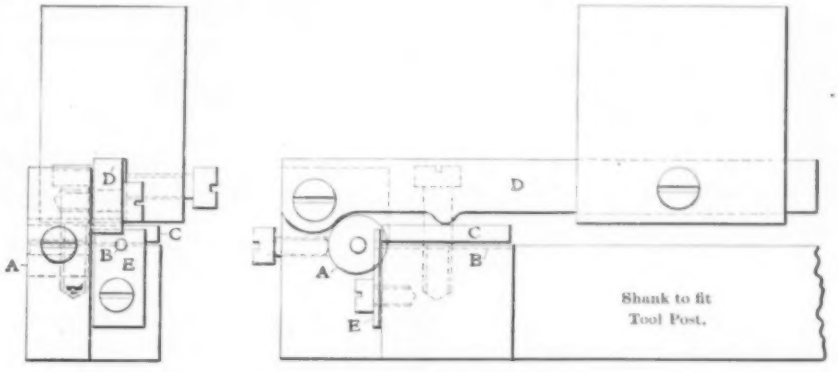
HOLLOW MILLS FOR SCREW MACHINES

Conrad uses a positive center bush for his hollow mill; but I should not like to have to work within a 0.005 finishing-tool limit with this, as I find a floating holder much better and easier for setting, for you can then locate the position, bolt the holder on the shank and go ahead.

M——, England. NOMAD.

Winding a Helical Spring with Initial Tension

I had an interesting experience some time ago in regard to the winding of helical springs with initial tension. The results were secured without my desiring to do so. We were winding a lot of open-coil or compression springs from 0.021-inch music wire on a 0.156-inch arbor, with a lathe geared to 20 per inch, in lengths of about 2 feet and cutting to desired length afterward. Shortly after the man had started on the job he brought me a spring with the coils closed together tightly and with a strong initial tension. He wanted to know "what's the reason." A slight examination showed nothing wrong about the lathe or guide, so after winding a spring and finding it all right I told the man to "change his drinks" and try again. Within an hour, however, he had two more freaks, so it was up to me to find out why.



TOOL FOR WINDING HELICAL SPRINGS

We were using the tool shown in the illustration in which the arbor is supported in the bushing *A*, while the wire is guided by a groove *B* in the top of the tool, being held therein by the top plate *C* and weighted lever *D*. I found that, in starting to wind the spring, a kink or bend in the wire would cause it to jump out of the front end of the groove and lap over the previous coil on the arbor, thus causing a reverse set in the wire. This was unnoticed in the winding, as the coils were necessarily held open by the guide. But on freeing the end of the wire they immediately closed up as stated. I cured the trouble by fastening a sheet steel-plate *E* on the tool. This had a small hole in line with the groove *B* through which the wire was threaded.

I was somewhat curious as to the initial tension and strength of a spring wound in this manner. Therefore I cut 3 inches off one of the springs and tested it with the following results: It sustained a weight of 5 ounces, before extension began, while a weight of 2 pounds extended it to a length of 8 11/16 inches, an opening of 0.0397 inch per coil. Under the latter weight for 13 hours the spring showed

no permanent set. A repetition of the first test gave the same results.

This was a surprising experience for me, but not so much so as would have been the making of the bevel pipe fitting described by D. R. Llewellyn at page 63. I have heard of the man who sat on the limb of a tree while he sawed it off between himself and the trunk, and have even seen a man who was reported to have done the trick. But this is the first recorded instance, to my knowledge, in which a machinist attempted to cut a piece of metal in two between the clamp and the face plate.

Philadelphia, Pa. C. W. PITMAN.

Horizontal Drilling Attachment for a Radial Drill

A radial drill and several different sizes of dynamo machine frame castings make up the job. These frames are only machined inside, the outside being rough and oval, as shown in Fig. 1. The holes *E* constitute the drilling operation, and they must be very accurately spaced. On the smaller of these frames a revolving jig is used, but on the larger sizes of the frames the size and weight prevent their being handled in this manner; so the frames are laid flat upon the drill-press base, the drill jig extending up *inside* the frame, and the holes bored in a horizontal plane with the fixture, Fig. 2.

Upon *A*, Fig 2, the spindle of the drill press, we mount the yoke *Y*, which is made to carry a horizontal drill spindle *S* which is driven from the main spindle *A* through the bevel gears *C C*. The spindle *S* is of course driven from the gear by means of a feather key. This auxiliary spindle at one end carries the drill chuck; the other is threaded to take the feed screw *P*, upon which is the operating ratchet *R*.

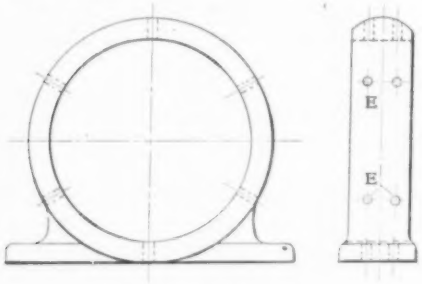


FIG. 1. THE WORK

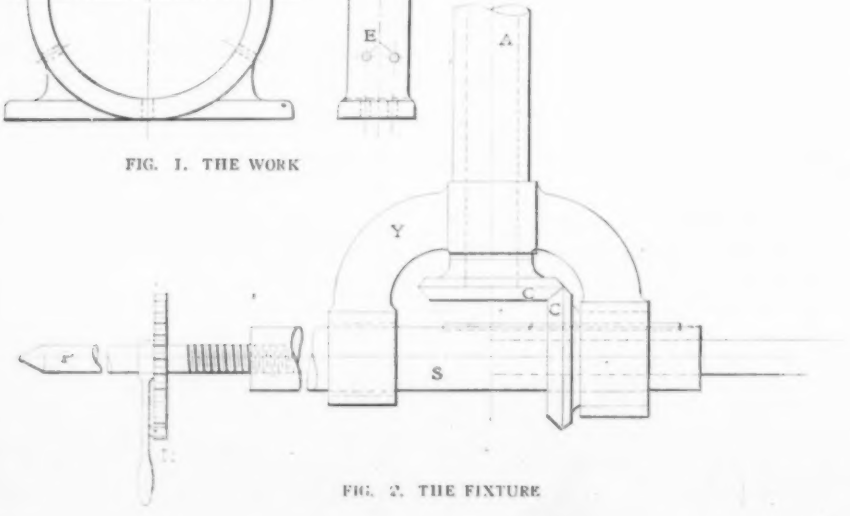


FIG. 2. THE FIXTURE

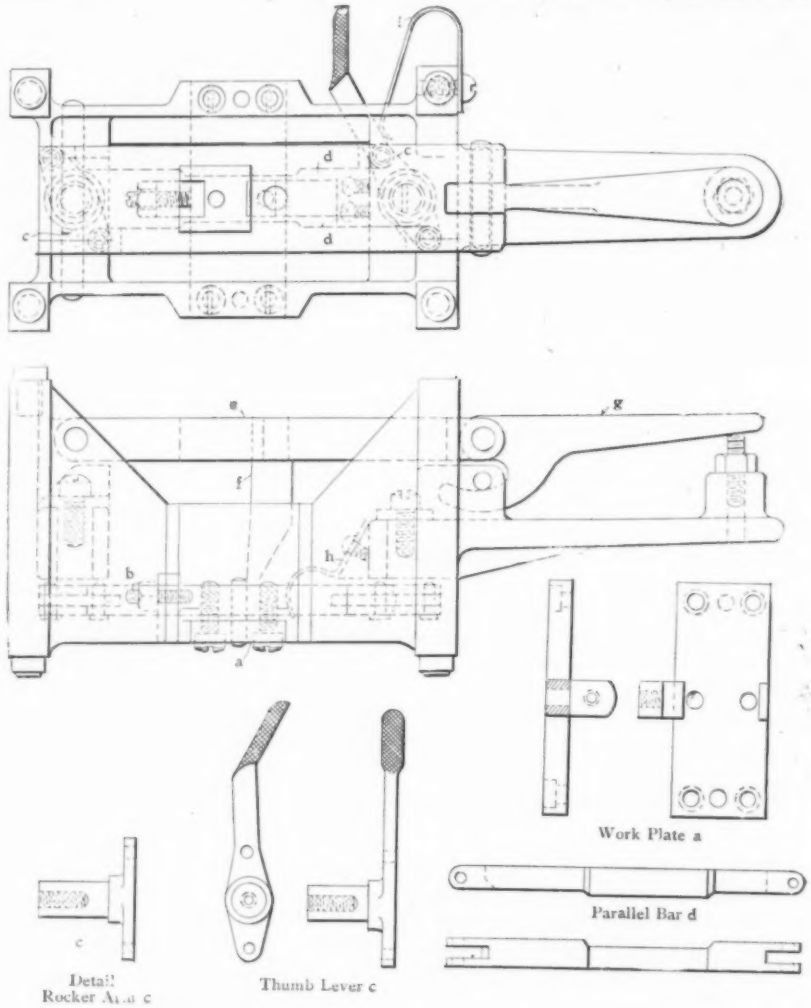
The drill is adjusted to the hole, and the screw *P* is unscrewed from *S* until it abuts against the opposite side of the frame casting. Any further movement feeds the drill into the casting.

It can readily be seen that *S* can be set at any angle in a horizontal plane about *A* and is of course adjustable to any vertical position through the main spindle of the radial drill.

Pittsburg, Pa. F. WILKENS.

Jig for Drilling a Small Plate

When the design of jigs and fixtures for any given manufacturing operation comes up for consideration, the question of proper location of gage points is usually a vital item and requires careful consideration, if the best results are to be obtained. Owing to unavoidable variations in the pieces to be operated upon, it is often the case that the usual fixed gage points are entirely inadequate to meet the requirements, and some system of automatically adjusting gage points is highly desirable. An instance of this nature recently developed, which led up to the design of the drill jig here shown.



JIG FOR DRILLING A SMALL PLATE

In this case the piece to be operated upon was a plain bar of copper, ¼ inch thick, ½ inch wide and about 1¼ inches long, the width being subject to an extreme variation of about 1/32 inch. The bar was to have two holes drilled through it, the requirements being that the holes should be in the center of the bar, regardless of the possible variation in width. As no two pieces were likely to come exactly the same width, the usual fixed gage points were evidently impracticable,

if the holes were to be maintained in a central position. Careful consideration of the requirements involved eventually led to the design of the jig herewith illustrated, which is of the cast-iron type, embracing the special requirements of an automatic centering device combined with the advantages of lightness and quick operation. It will also be noted that the bottom of the jig is cast open, permitting the chips and dirt to fall away readily.

The plate *a* is attached crosswise of the bottom and carries the adjustable stop screw *b* for locating the work endwise. The opposite ends of the jig casting are bored to receive the shanks of the double rocker arms *c*, which are in turn connected by the two parallel bars *d*, which pass over the work supporting plate *a*, with a small clearance sufficient to prevent dirt and chips being caught in the corners. The supporting surface of the plate *a* is slightly raised as shown to facilitate cleaning as well as to increase the clearance between the parallel bars and the plate. One end of the double rocker in the handle end of the jig is extended beyond the side of the jig, terminating in a thumb lever easily accessible for the operation of the parallel bars *d*, which operate on the principle of a parallel ruler. The jig is also provided with a swing clamp or lid *e* fitted with the stud *f*, the whole being secured by the cam *g*.

In operation the thumb lever is pulled back, opening the parallel bars to their full capacity, when the work is placed between the parallel bars upon the plate *a* and held against the stop screw *b* by means of a light spring *h*. The thumb lever operated by the spring *i* is then released, closing the parallel bars and effectually centering the stock with the bushing holes in the plate *a*, regardless of any variation in width. The lid is then closed and secured by a single movement of the cam *g*, when the stud *f*, projecting downward, clamps the work ready for drilling. It is evident that the holes for the shanks of the rocker arms should line with the bushing holes in the plate *a*, also that the rocker arms should be of the same length and the working faces of the parallel bars should be equally distant from the center line.

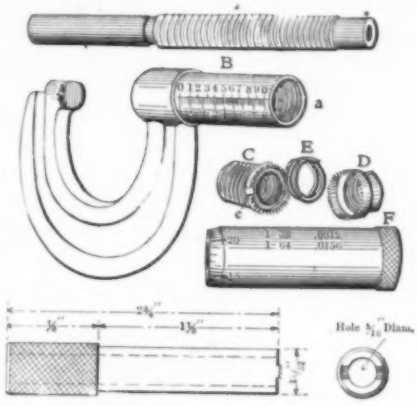
On account of an anticipated large production, the jig is provided with hardened cast-steel feet, while the square hole in the cover or lid is to accommodate a projection on one end of the work.

Pittsfield, Mass. H. D. PENNEY.

A Tool for Removing the Nut from Slocomb Micrometer

The illustration shows a device that will be found extremely useful for mechanics using the Slocomb micrometer. It consists of a piece of steel with a hole drilled through, to fit over the spindle in the thimble, and teeth cut on one end as per sketch.

In the Slocomb micrometer the nut *D* sometimes loosens and then disengages itself from nut *C* and gradually works itself to the bottom of the thimble *F*, preventing the use of the micrometer for small measurements until the nut *D* is



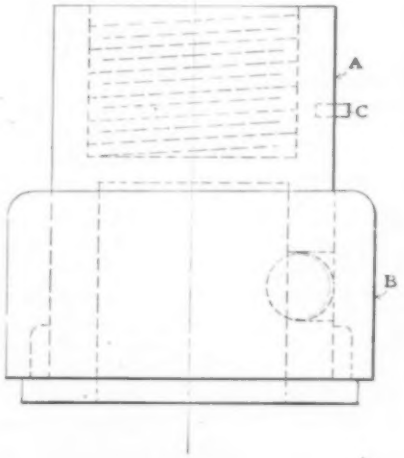
TOOL FOR REMOVING THE SMALL NUT FROM A SLOCOMB MICROMETER

removed and readjusted to position in the nut *C*. It is a very difficult matter to remove the nut *D* from the thimble *F*. Many have tried to back the nut out with a scratch awl, without much success and at the expense of a great deal of time and patience. I designed this simple tool for removing the nut. The teeth in the end engage with the teeth in *D* and it is easily removed.

New London, Conn. MAX JAEGER.

Another Ball Drill Chuck

The article on page 169 in regard to ball drill chucks calls to mind a similar chuck



ANOTHER BALL DRILL CHUCK

which we use, which is simpler and cheaper to make and answers the purpose just as well. *A* is a sleeve, bored and threaded on one end, bored to fit the reamer at the other end, and recessed for the ball, as shown. This hole is tapered enough so that the ball cannot fall through.

B is a collar, bored a running fit for *A*, and is counterbored, so that when it is raised up to the pin *C*, the ball falls into this counterbore. When the collar *B* is down, it strikes the flange of *A* and holds the ball in place.

A Morse taper shank can be threaded to fit the sleeve *A*. The sleeves are all made to fit these shanks, which saves a great deal of time and material.

Syracuse, N. Y. D. A. MUND.

Troubles of a Tool Designer

I was interested in the article by W. J. Baker, on page 624, entitled "The Troubles of a Tool Designer." While recognizing that his assertions are to a certain extent correct, it seems only fair to look at the situation from another point of view, which is more satisfactory than the one taken by Mr. Baker. Speaking as a draftsman in this line of business, it has always been a fond imagination of mine that a tool designer has the right to consider his work just as indispensable as the ordinary machine designer. Rejoicing in this knowledge that we are indispensable, why should we be troubled at what others say or think, be they shop men, management or what not?

My experience regarding the attitude taken by the different men through whose hands the tools pass is somewhat different. In several shops in which I have worked, it has been the custom for draftsmen to consult frequently with the toolroom foreman upon matters pertaining to the easy and economical manufacture of tools, and I have never yet found one who would kick at a design being too simple, providing the work was turned out in an efficient manner. This custom, I think, tends to reduce the friction which generally exists between the drawing office and the shop, and eliminates a great amount of trouble. I do not think it necessary to pay much attention to the kicks coming from the users of labor-saving tools unless there is sufficiently good reason given and I am convinced an improvement can be made; in such a case, I say it is a pleasure to have learned of the fault. Otherwise it is much better to ignore such grumbles.

Speaking from a thorough experience as toolmaker, I do not believe the average shop man bears any animosity toward a good tool designer, but on the contrary is always glad to have, and always appreciates, his explanation upon any point which is not perfectly clear. Most of the trouble comes from the horde of inefficient and improperly trained men who are filling, or trying to fill, positions at the board. When the drawings from these men get into the shop without be-

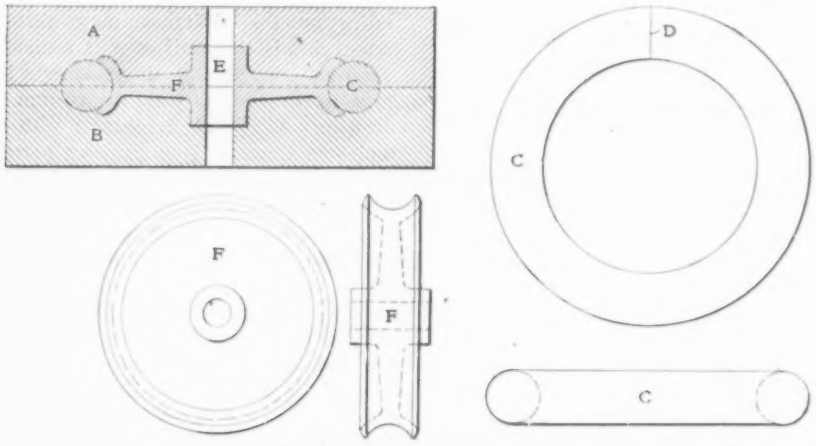
ing properly checked and approved, can we wonder that the shop men say harsh things of draftsmen in general?

So I am bound to say, that the position of a good man seems one to be envied. He has increasing facilities for developing and practising individuality and originality in the large scope of work which is open to him. He can sell his talent in almost any mechanical market, be it typewriters, automobiles, machine tools, printing machines or a host of other lines. The lack of good men, with an ever increasing demand, tends toward independence and practically insures proper and generous treatment of a good man. With these difficult advantages minor troubles can safely be ignored and treated as necessary evils which are "only sent to try us."

Rochester, N. Y. SHOLTO MCKIM.

Casting Grooved Pulleys in a Two-part Mold

We had some white-metal grooved pulleys *F* to make. At first a simple two-part mold was made which produced a casting with a flat face, the groove being turned afterward. The first lot being satisfactory a larger order was given and I had almost decided to make some elaborate three-part molds when the mold shown in section occurred to me. *A* and *B* are the two halves of the mold, *C* is a wire ring split at *D*. This ring was a snug fit in the mold. It was made of 3/16-inch wire and was about 4 inches in diameter. A drill-rod spindle *E* was put through the two parts from side to side and was forced out under an arbor press after casting the grooved pulley. The pulley *F* and ring *C* came out of the mold together. The ring *C* was easily sprung open and off the pulley and replaced in the mold ready for another casting. A touch with a scraper was all that was necessary to finish these castings in the lathe. Except at the gate these pulleys as they came from the mold ran within 0.002 of true.



CASTING GROOVED PULLEYS IN A TWO PART MOLD

New York, N. Y. E. A. DIXIE.

Thread Milling on the Speed Lathe

Fig. 1 is a bronze casting finished all over and having at *A* a standard Acme thread, ten per inch. These pieces were formerly threaded in a lathe on centers; but this process was slow and expensive, and the pieces were often sprung or the threads not perfect.

The fixture, Fig. 2, was made for milling the thread in a speed lathe; when in use, a boy could do about three hundred a day and the work was uniformly smooth and accurate.

A cast-iron frame *B* was machined on the bottom to fit a saddle plate with which the lathe was equipped, the correct angle between the lathe centers and the fixture being maintained by a feather fitted to a slot in the saddle. A corresponding slot was milled across the bottom of the fixture at the angle of the thread. The distance from the saddle plate to the lathe centers was then carefully measured and the frame bored at both ends, one to receive a hardened bushing and the other of sufficient diameter to allow the projections on the work to pass through easily.

A machine-steel bushing was then turned to fit the large hole and threaded internally with a standard V-thread, ten per inch. Grooves were cut in the outside of the bushing, as at *C*, which fitted pins driven into the castings at *D* and allowed the bushing to be locked in place or removed by a slight turn. The grooves should be of the same hand as the thread to be cut, so that there will not be a tendency to loosen the bushing while milling the thread. To this bushing is fitted a machine-steel plug *E* threaded externally.

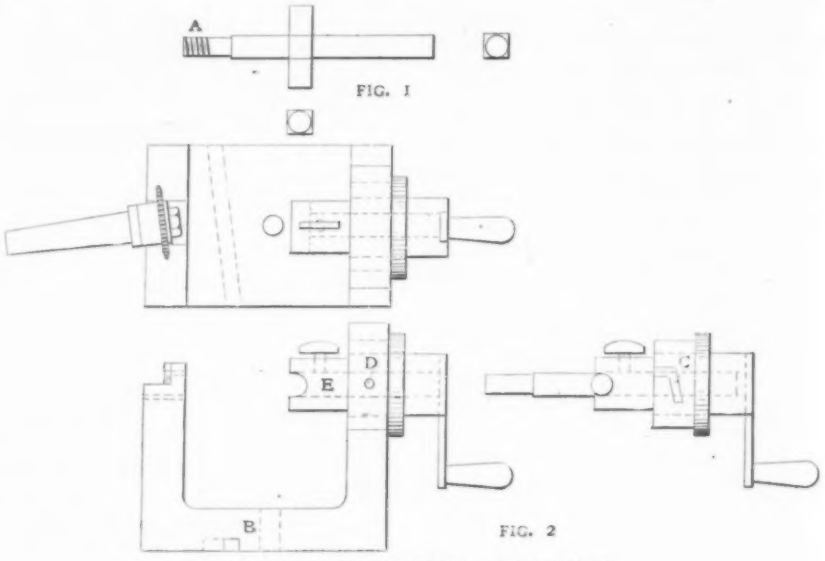


FIG. 2

THREAD MILLING IN THE SPEED MACHINES

One end of this plug has a handle by which it may be turned; the other end is fitted as a chuck to hold the work. In this case it was bored longitudinally to a snug fit on the shank and grooved crosswise a loose fit on the lugs. A thumb screw assisted in holding the work.

The cutter was turned the correct diameter to give the necessary depth of thread and held by a short arbor in the spindle of the lathe. The fixture was bolted to the saddle plate with the cutter directly over the hardened bushing which was to act as a guide for the end being threaded, and which had been partially cut away to make room for the cutter.

The bushing and plug were removed from the frame, the work inserted and the parts replaced and locked; then by turning the crank, the work advanced on the cutter at the proper rate to cut the desired lead. The cutter was always stopped in removing the work, as the slightest lost motion or the chance unlocking of the bushing would injure the thread.

The fixture could be altered for work of various kinds and could be much simplified, dispensing with the bushing, for work without projections.

For threading steel it would probably be necessary to drive the work by gearing of some kind to get a motion sufficiently slow and steady, but for bronze the single crank was satisfactory.

Alpena, Mich. E. C. O.

Government Inspection

Several articles have recently appeared in the AMERICAN MACHINIST regarding Government inspection, but all have been from the contractor's point of view. A few remarks from the inspector's side may, therefore, not be amiss. I once held for a short time a position as civilian inspector in one of the principal Government departments. Considerable trouble was experienced with electric motors which had been over-rated by their makers; to prevent this, complete specifications were drawn up for their purchase. Advance copies of these specifications were sent to the principal electric companies for their comments, and the final draft was made to conform to the desires of the majority of the manufacturers. The main feature was the allowed heating limits, and there was a surprising difference of opinion among the makers regarding this.

The department wanted first-class machines and was willing to pay a good price for them, therefore the heating limits were made rather low; but in no case were they made lower than the figures recommended by some prominent company, and in some cases they were more liberal than some companies desired. Taken as a whole the specifications were rather severe, and they were quite rigidly enforced; but any of the high-grade standard makes could pass them, and hundreds were purchased from many companies without the slightest difficulty. If any motor was slightly deficient in one particular but exceeded the requirements in others, the deficiency was almost always waived and the motor accepted.

Occasionally, however, some maker who had no experience with Government methods would take a contract and be greatly surprised to find out that the specifications "meant what they said," and would be very indignant to have a motor rejected because it ran hot. In one extreme case an inclosed motor emitted clouds of smoke after running at full load for less than one hour, although specified to be for continuous running at full load. Such instances were rare and were seldom repeated by the same concerns. The rigid enforcement of these specifications was an advantage to reputable makers, as it protected them against any unscrupulous bidder who might submit a low bid with the intention of supplying under-rated machines. Also, in several cases it stimulated the improvement of design, so as to obtain better ventilation and produce cooler running machines.

Another phase of the situation, not generally appreciated, is that if an inspector on his own volition waives any requirement and afterward the machine or material fails in service, the inspector's record and standing with his superiors will be greatly impaired. This applies especially to commissioned officers detailed to inspector's duty, whose records are accurately kept. On the other hand, he will receive no credit for waiving superfluous or ridiculous requirements, and thus has no chance to balance his account in this respect. This condition very naturally acts as a damper on the use of personal judgment. Superimposed on the above facts are others: owing to the scarcity of officers they are often sent to inspection duty on work with which they have had but little experience, and with the best of intentions the original writer of the specifications will sometimes use phrases that cannot be literally complied with; it is readily seen that most vexatious situations can arise.

It is no uncommon thing for private firms to enter into contracts with each other which are impossible of exact fulfilment, but they have no great difficulty in making a satisfactory settlement between themselves. Such a course would be ruinous with a Government contract, as those who have detailed knowledge of the conditions would not have the authority to settle, and those who have the authority are very prone to decide to "adhere to the specifications." The manufacturer of a specialty, which can be practically sold over the counter on catalog description and without specifications or tests, obtains the most benefit from Government sales. All others must expect a large amount of trouble and vexation for a small profit.

Boston, Mass. E. C. RHOADS.

More about Chemical Analysis

The comments of August H. Nolting on a recent editorial in the AMERICAN MACHINIST entitled, "Does Chemical Analysis Tell the Whole Story?" voices an opinion often heard, particularly in the foundry business. While Mr. Nolting's case is hardly a fair illustration (as a chemical analysis can seldom of itself give the method of manufacture), it must be confessed that all too frequently chemical analysis is of very little value for the solution of the problem which caused it to be made. Nor is it very difficult to find the reason. As usually made, chemical analysis of inorganic substances is elemental or ultimate; it gives the constituent elements, but not their combinations. In this it differs radically from analysis of organic compounds, which usually are proximate, giving the proportions of the various compound bodies that go to make up the original; ultimate or elemental organic analysis is made only to determine the composition of these compounds. As there are a great many organic compounds which, while they have the same percentage composition of hydrogen, carbon and oxygen, are totally different from one another, not only in physical qualities, but also in their chemical relations, the organic chemist has been forced to develop methods of determining these different compounds as such.

ELEMENTAL COMPOSITION

The inorganic or mineral chemist, on the other hand, has thus far been content to express his results in terms of the ultimate, elemental composition. It is right here where inorganic analysis is usually a failure, as far as the purpose for which it was made is concerned. In the case cited by the AMERICAN MACHINIST the elemental composition of the defective steel was the same as that of the good steel; yet they were totally different, because, no doubt, the carbon was not in the same combination with the iron in the two cases. A microscopical or micro-chemical examination of the steel in question would, no doubt, have settled the question as to this point; but it would not have been of any assistance to the manufacturer of the steel as far as insuring the production of a uniform article goes.

FAILURES OF STEEL

An impartial comparison of iron and steel products of today with those of 25, 15, or even 10 years ago will convince anyone that not all progress in the iron and steel industry has been in the direction of improved quality. That something is wrong somewhere in estimating the qualities of modern iron and steel seems evident when the appalling number of failures in iron and steel structures to do the assigned work is considered. Be the accident the unexpected collapse of a steel structure, be it the breaking of a rail or the bursting of a boiler, there are many cases in which the charge of carelessness cannot be sustained, and the true cause must be sought in hidden defects in the material used, which the ordinary most approved methods of testing failed to reveal.

While microscopical and micro-chemical examination in these cases usually reveals approximately the cause of failure, it cannot be denied that these methods are essentially qualitative and not quantitative. There seems very little hope that any quantitative microscopic or micro-chemical methods can be worked out that will be of any value except in the hands of the most highly trained specialists.

DETERMINING QUALITIES

That quantitative chemical relations are of vast importance in determining the qualities of steel and iron, there can be no manner of doubt. These quantitative relations should, however, be those of the various compounds and not of the elements that compose the latter. True, it is usual to make a distinction in iron and steel analysis, between combined and graphitic carbon. As it is now, however, generally admitted that the combined carbon in iron and steel may exist in a number of "carbides of iron," each of different

composition and quality, each having a different effect upon the nature of the steel, it is readily seen that a determination of combined carbon as usually made has but little real value.

When it is further considered that only certain ones of these carbides of iron are affected by the sudden change of temperature incident to the processes of hardening and tempering, it becomes apparent that a proximate and not an ultimate or elemental analysis is required.

Hardening Carbon

In the steel in question the percentage of combined carbon no doubt was the same but not of the so called "hardening carbon," that which exists in that combination with iron which on sudden cooling will be transformed to such an extent as to produce the required hardening. Graphitic carbon frequently is a varying mixture of flakes and amorphous powder; sulphur is often found in such form or combination that it will on solution of the iron in acid not escape as sulphureted hydrogen but probably as some sulphur compound of carbon; and silicon as usually determined often comes partly from included slag as well as from the iron.

At the high temperatures now used in the blast furnace, many of the rarer metals are unquestionably reduced and mixed with the iron which formerly went into the slags; and ordinarily chemical analysis ignores these or by methods frequently used includes them with the silicon. That under these circumstances such an analysis is not very satisfactory is certain.

Needs of Mineral Analysis

What is needed, not only in iron analysis, but through the whole field of mineral analysis, are methods of proximate analysis so that the "proximate" constituent compounds can be determined. In a limited way this is being done in clay analysis for the ceramic arts and in agricultural work, notably in soil analysis. The difficulties, however, that must be overcome before we can hope to have methods of "proximate inorganic" analysis that in any way parallel those of organic chemistry are very many. The organic chemist usually has available one or more of those methods of separating his bodies without changing them; fractional solution by the use of various solvents which act differently upon different bodies; fractional distillation and fractional solidification.

Inorganic substances, on the other hand, can only in a very few instances be separated without being transformed into other chemical compounds. In soil analysis and in rock analysis use is made of varying specific gravity to effect a mechanical separation of the different constituents, and an extension and improvement of these methods would no doubt be possible.

The greatest difficulty to be overcome is that of grinding fine enough to separate all the constituents, and secondly, of finding a liquid of proper density to separate or grade the constituents without changing their nature. Proper solvents might also be found which under the influence of a properly regulated and adjusted electric current of correct voltage would effect differential solution, by a reversal of the processes of electro deposition of alloys.

As already stated, the difficulties are very great and the consequent expenditure of time and money would be such that no individual investigator and probably no single institution would be able to undertake the development of such methods, much as they are needed. It would seem that no better and more appropriate field of research could be found for the expenditure of part of the Carnegie research fund.

Buffalo, N. Y. Wm. H. Dopp.

Having carefully read your leader which bears the above title and also the letter of August H. Nolting, I have been thinking that a few cases from my own experience in which chemical analysis did tell the whole story might possibly interest your readers. As a case in point, a certain firm wished to make some castings like those imported from another country, but were unable to do so with any of the grades of metal which it regularly produced in its own iron foundry. The castings were remarkably light and thin as well as very flexible, considering that they were made of cast iron. A few of these imported castings were sent into the firm's chemical laboratory for examination. Their composition was ascertained by careful analysis, and various grades of pig iron, including one or two special qualities, were so mixed that they would give molten metal at the cupola spout practically identical in composition with the foreign castings. This metal answered admirably, and many hundreds of thousands of these articles have since been made and sold.

Again, a bronze which was brought as an alloy of copper, 9 parts, and tin, 1 part, did not give the results which such an expensive metal should give, and was the subject of loud complaint. Chemical analysis showed that the seller had delivered an alloy containing 6.3 per cent. lead, 9 per cent. zinc and only 3.7 per cent. of tin; here again chemical analysis showed the cause of the trouble quite plainly.

When red lead does not make good joints that will keep tight, one is not much surprised at the fact when chemical analysis shows that the red lead (?) contains less than 30 per cent. of real red lead (the remainder being powdered gypsum, etc.,) and the white lead over 23 per cent. of impurity, an amount which is not incidental to manufacture and must be set down as intentional adulteration. Another case concerning cast iron comes to my mind. Two batches of castings had to be tooled on a milling machine. The machinist reported that the metal of the first batch was hard and of the second so very hard that it could be machined only with great difficulty. Analysis of the cuttings from both batches showed very little difference between them except with regard to the figures for sulphur. In one case this element was present to the extent of 0.11 per cent. and in the second to 0.19 per cent. Those of your readers who know anything of the metallurgy of cast iron will at once acknowledge that here again chemical analysis told the whole story.

I am quite aware that there are some cases in which analysis fails to provide an adequate explanation of observed facts, but my contention is that it succeeds much more frequently than it fails. Steel is a most complex material, the properties of which are entirely altered by heat treatment; unfortunately chemical analysis does not give us any information as to the heat treatment which a sample of steel has received. It is here that the microscope is found of great use, for the microscopic appearance of steel which has been overheated differs very considerably from the same steel before such overheating. It would be interesting to know whether the steel referred to in your leader was regularly subjected to microscopic examination as well as to chemical analysis.

Your correspondent, Mr. Nolting, rather decries the chemist and his ability; but I think that if he fully recognized how much the manufacturing world of today is dependent on the chemist, he would have more respect for the part which he is playing. It is the chemist who controls the making of almost all the materials which the engineer and machinist make use of. Iron, structural steel, high-speed tool steels, alloys, lubricants, abrasive materials, liquid and gaseous fuels are produced in all the best and most modern works under the direct supervision of men well versed in chemical science.

Eastbourne, England. Roheisen.

Grinding Valves In

A good tip for grinding gas-engine, automobile valves, etc., is to slip a short spring on the stem of the valve, then put the valve in place and grind it in. The spring will lift the valve off its seat to get a fresh grind as often as you wish, without taking the grinding tool away. I find by this method valves can be quickly and effectively ground in and a splendid surface obtained by the often repeated lifting from the seat during the grinding operations. Percy Mellor.

Birmingham, England.

Why is a Planer Bolted Down?

Will you kindly ask your readers to tell us why a planer is bolted down to the foundation? Ever since my childhood I have seen planers bolted down, and the foundation plans always show a very long, large bolt, carefully located and embedded in the foundation, evidently with the intention that this bolt must hold something that will be constantly making an effort to get away—on the principle that we tie a fractious horse to a post with a strong halter.

Some time ago in our works we planned some adjustable plates upon which to rest planers in order that the alinement of the planer could be corrected at any time. It was found impractical to bolt the planer down to these plates, and I assumed that the planer did not need to be bolted down. However, someone persuaded me to place some small pins, against which the planer could thrust, to prevent the planer from gradually creeping off the plates. This was done in the case of two planers. Later other planers were set up; nothing was provided to keep the planers from creeping off the plates, and certainly no bolts to hold them down. The last planer was a Pond planer 26 feet long by 60 inches square—quite a heavy one. The forward traverse has four speeds, the fastest of which is 50 feet per minute. The return traverse is 90 feet per minute. This planer was placed upon the plates on the foundation and is not in any way held, sideways, endways, or vertically, by any kind of bolt or locating device. It has been running now for a long time and we cannot discern that it has moved a thousandth of an inch from the position where it was placed in the beginning.

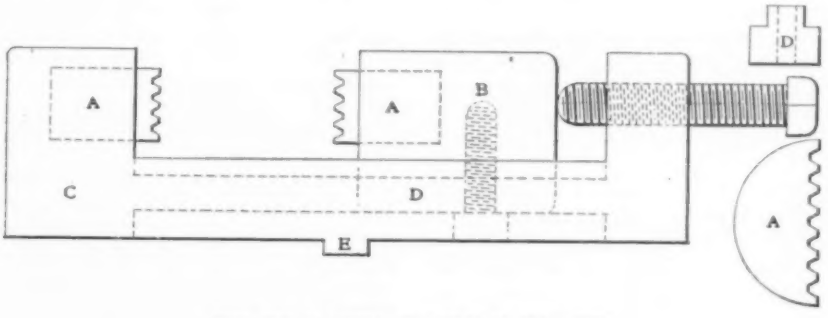
In the introduction of cylindrical grinding machinery I found it very difficult to persuade earlier customers that it was not necessary to bolt down grinding machines to a foundation; in fact, one party, after the machine was erected and in running order, drilled holes in the base and bolted it down, so certain were they that it was necessary to be done. No Norton grinding machine has ever been made with any provision for bolting it to the floor or foundation, and there are reasons why it is unwise to do so. There are many other machine tools which I know from experience will never leave the position in which they are placed, even if they are not bolted to the floor or foundation. The practice, however, still continues. Planer makers still send out foundation plans showing these bolts. In fact, the bolts are a prominent feature of the plans.

Would it not be interesting if you could induce readers of the AMERICAN MACHINIST to give their reasons why planers and many other machine tools are bolted? I feel that the bolting down of a planer has some relation to some tradition that the present generation knows nothing about, for I am quite certain that four planers at least do not need bolting or holding in any position, and it would seem wise for us, in this economical age, to abandon all of this fuss about bolting if it is not necessary. May we not hear from your readers?

Worcester, Mass. C. H. NORTON.

Vise for Planers or Milling Machines

The illustration shows a planing and milling fixture I have found useful. As you see in the diagram, it is a sort of vise with swiveling jaws.



VISE FOR PLANERS OR MILLING MACHINE

It is made a suitable length, with about four places on each side for jaws *A*. They can be made either of cast iron with a hardened-steel serrated plate or all of steel. The places for the jaws can easily be milled the same radius as the swiveling blocks. *B* is the bar holding the jaws and is movable. There are three slots in the fixture, as shown in the diagram, into which part *D* slides. *D* is fastened to *B* with a bolt. *E* is a tongue which lines up the fixture.

It has a large scope for holding work for planers and milling machines. All four jaws are used in holding the work, and they can be set to accommodate its length. The fixture is very simple, can be made easily, and the advantage of having the jaw swivel is that it does not spring the work. In tightening the set-screws, the jaws move up and tighten, and swivel to the form of the casting; when work is finished, it comes out true.

Cincinnati, Ohio. GUSTAVE LORENZ.

Fiber Friction Washers

On page 575 I noticed an article by S. P. Yeo, on "Fiber Friction Washers," in which he states that data on this subject are comparatively scarce, so I thought that my own experience with vulcanized fiber might be of interest to Mr. Yeo.

Last spring I built and installed a two-cylinder gasolene motor in a 21-foot launch. While figuring on the design of some form of thrust bearing for the propeller shaft my attention was called to the thrust collars on a large drill press in the shop where I was working. These collars were of vulcanized fiber ¼ inch thick and had replaced phosphor-bronze collars two years ago, having given perfect satisfaction since that time.

Believing this service to which my thrust bearing was to be put similar to that of the drill press, I accordingly constructed two fiber collars 1/16 inch thick and 3 inches in diameter, with holes bored in them for a 1¼-inch shaft, these disks or collars being, of course, suitably grooved for oil.

The boat mentioned was run throughout the summer, and the thrust bearing worked admirably. The oil which worked through from the crank-shaft bearing of the motor was practically all taken up by the thrust collars, and after about a month's usage these collars seemed to have taken on the glaze which Mr. Yeo mentions.

When the motor was running at about 600 revolutions per minute, the boat was making a speed of 9½ miles an hour. This gave the propellor shaft a thrust of approximately 165 pounds, thus making the pressure per square inch on the fiber disks 28.7 pounds. But here is where the "rub" comes in with the use of vulcanized fiber. I had occasion to observe the action of this material under different conditions, and it proved itself wholly undesirable for this work. The use to which it was put in this second instance was as a part of a "timer" on a small gasolene motor. The construction of the timer was as follows: A bushing had been made of fiber and a small brass strip for electric contact set in one side of it. The bushing was placed over the crank-shaft and a flat steel spring was made to bear upon the former constantly. The pressure of this steel spring on the fiber bushing was very slight, yet this spring was noticed to wear rapidly at the line of contact, it being necessary to replace the first spring in a very short time.

The logical conclusion to be drawn from these two cases is that vulcanized fiber contains a certain amount of grit which acts as an abrasive when subjected to light pressures but which takes on a glaze under heavy pressure. This seems to be somewhat analogous to the

action of grinding wheels which take on a glaze after hard usage and require dressing with the diamond tool to bring them to suitable condition for cutting again.

It would therefore appear that if vulcanized fiber were subjected to a treatment of rolling under heavy pressure and thoroughly saturated with oil, it would at once take on a glaze which would make it proof against wear and also take away its abrasive properties, thus making it a very suitable material for thrust collars and other uses.

Indianapolis, Ind. J. G. Wood.

Calking of Line Pipe

The old and cumbersome way of making a joint in the laying of pipe, in which it is calked with rope and molten lead, has many disadvantages: First, that of being confined to a very limited amount of space, as is often the case; and next, while in this cramped and uncomfortable position, having to handle a ladle of molten lead. After building a series of canals to enable it to run uphill, as it were, the lead is poured into what often seems to be a thirsty pipe, because it is leaking into the pipe, causing it to be rough, thereby making eddies which must affect the head.

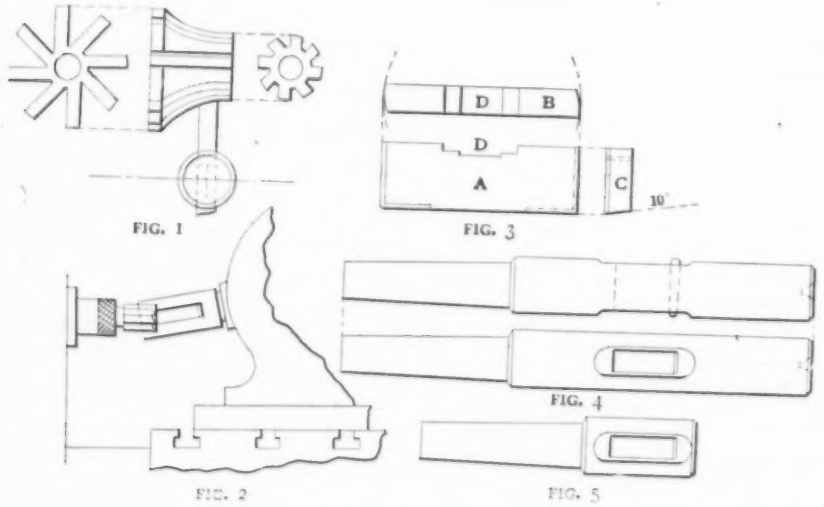


FIG. 1 FIG. 3

FIG. 4

FIG. 2 FIG. 5

MAKING BORING-BAR CUTTERS

These difficulties are almost entirely eliminated if the lead be cold and in shreds, known as shredded lead. It is put into place and hammered much the same as is the filling of gold in a tooth. The lead, thus hammered, becomes a solid mass of metal, making a perfect joint, which is far more easily calked than in the old method previously mentioned.

The writer has had occasion to use this method of calking and has found it much more efficient than any other.

C. W. Clifford.

Philadelphia, Pa.

Making Boring-bar Cutters

About 15 years ago I had charge of a tool room where they made large quantities of boring bars and cutters. Their method of making the cutters was as follows:

The blanks were cut off in the smith shop, milled to size for the slot through the bar, the cross slot milled for a seat in the center of the cutter. Then they were keyed in a bar and turned off to grinding size. After turning the relief was filed by hand. The method was too slow, and I devised the following method:

A, *B* and *C*, Fig. 3, show front, side and end views respectively of the cutter to be made. The blanks were first cut off by the smith or in the milling machine, allowing about ⅛ inch for finishing on the ends. They were then milled on the four sides to size. I had a special cutter for milling the seat slot marked *D*, which conformed to the size of our standard bars.

To mill to diameter and give the required relief at the same time, I used a special milling cutter, which is shown in Fig. 1. We used the index head and a special arbor, two views of which are shown in Fig. 4, which fitted the index head spindle.

Fig. 1 shows the milling cutter and a boring cutter in milling position. You can readily see that by moving the milling-machine knee up and the table in that you can get any desired size or amount of clearance. For milling the face relief on the cutter, we used the index head set parallel with the milling-machine spindle and inclined down 10 degrees, as shown in Fig. 2, using a special adapter to hold the cutter shown in Fig. 5.

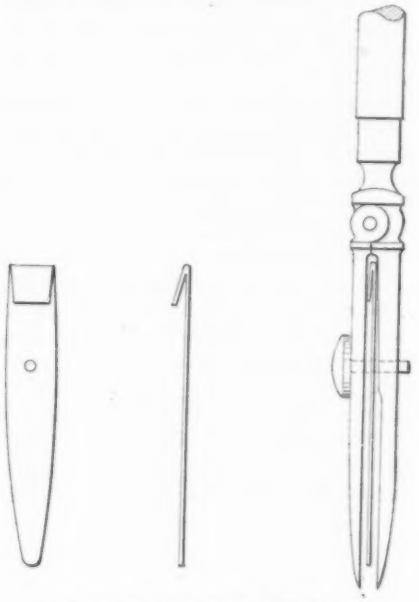
This method was very rapid, as it did away with nearly all the handwork as well as the slow process of turning off the cutters in the lathe. Of course this can be improved greatly by more elaborate milling fixtures.

Grand Rapids, Mich. F. C. Mason.

Attachment for Drawing Pen

The ordinary drawing pen will not hold sufficient ink to enable one to draw a broad line of reasonable length.

A simple attachment to enable the ordinary pen to be used for broad lines is shown in the sketch.



ATTACHMENT FOR DRAWING PEN

A thin piece of steel is filed and bent to shape. A hole is drilled a shade smaller than the diameter of the adjusting screw of the pen. When screwed in, the strip is kept tight on the screw and central between the nibs. The strip can be swiveled round so that the pen may be easily cleaned and can be taken off when not required.

Birmingham, England. M. Ernest.

Cutting Threads with the Compound Rest

On page 806, No. 47, Vol. 30, of the American Machinist, there appears an article on this subject under the heading, "Cutting 60-Degree Threads," which calls for some criticism. The writer says, "It is better to set the compound rest at 28 degrees or 29 degrees so as to have the tool finish one side while it is roughing the other."

Experience teaches that it is not good practice to finish one side of a cut while roughing the other if the finished side requires to be accurate. Nor is it advisable to have the back side of a thread tool cut while roughing with the front side, since even a small chip from the back is liable to mix things with the heavy one from in front in such manner as to cause unpleasant complications, inducing the very

difficulty we seek to avoid by using the compound rest. It is not, under ordinary circumstances necessary to cut away the back of the tool, it being an easy matter to obviate any tendency to chatter or gouge by backing up slightly on the cross slide and feeding in so much farther with the rest, thus clearing the back of the tool from the work.

By manipulating the two screws in this manner it is possible also to finish each side of the thread independently of the other with the rest set at an angle of 30 degrees, although the idea of placing it at right angles to the cross slide may perhaps work better under certain conditions.

In work of this description, as in many other kinds, it is very convenient to have an index on the compound-rest screw and I am unable to understand why so many tool builders neglect this very simple and inexpensive feature, while adding so many improvements to our modern lathes.

Cleveland, O. C. H. WELLS.

A Plea for the Simple Lathe

During the past few years I have been intimately connected with two manufacturing plants making a widely different product of medium weight and, in the case of one of them, a line of parts numbering nearly twenty thousand. From my observations I am firmly convinced that the development of automatic machines and complicated hand machines has gone too far. I am at present handicapped with an equipment of expensive hand and automatic turret lathes which require almost daily change, and to make these changes and run the machines as they should be run would require a tool department ten times the size of the one which we have. Many times I have read in your columns, with feelings of envy and wonder, the description of the method of machining a certain part, with the evident lack of haste and with the patience of the proprietor who would stand for the careful consideration of each detail and never compel you to go ahead until everything was ready.

In nine times out of ten, with me, a turret lathe will run out at 9 o'clock and the castings for the next job have been delivered. The sketches and specifications for the tools have been in the tool department for a month. Some of them are finished, some are half finished and others not touched at all. The assembly department is held up for the parts and must have them or production will be stopped. So the job is started and the piece produced somehow with other tools and various makeshifts. When the next part turns up, the same thing with variations is gone through with again. "Lack of executive ability!" you say. I sometimes think so myself. Still I don't get fired and am rather of the opinion that the "old man" has more imagination than plant, and I have never struck an "old man" who did not have this failing.

I will tell you how these "wonder-working" machines, which will do the work of from four to eight lathes, make good. One is purchased and set up; the expert demonstrator arrives; the first job you want is shown to him. He puts one of the pieces in the chuck; it holds, but a special set of jaws would be much better, so hurry orders are given to the tool department for a set of jaws; then the first cut is started and a special form of tool had better be forged for that cut, so a tool is ordered forged and the operator is told to wait for it. Meanwhile the other tools and operations are being overhauled with the result that, before noon, four toolmakers are driving ahead and the tool dresser and his helper are working at full pressure. All this to get the results of which the machine is capable, and when the result of this thought and labor is properly placed in the machine the results are "wonder working." This is small comfort to you, however, for, by the time the "wonder worker" has struck its gait, you are pacing up and down the floor with three more jobs for it on tap and all the preliminary symptoms of nervous prostration. After the expert demonstrator has left the job is torn down and another one started; but, lacking the ability to put a force of men on a comparatively insignificant but necessary piece, the next piece gets scant consideration and the machine gives poor results.

Some years of this kind of experience has convinced me that the standard type of engine lathe has not yet come into its own, and that few realize the economy and results which can be obtained by subdividing the making of a single part among a group of lathes. Nearly all of the tool work for such subdivision can be done by the lathe operators themselves, and they never have to kill time while a high-cost tool department is working that they may work. A steel bevel gear about four inches in diameter, which had a clutch on its face and a long hub for its own shaft, is a case I have recently had brought before me. This part had been manufactured on a turret with the help of an expensive set of tools; the design of the gear was changed, however, thus scrapping the tools. There being no immediate possibility of getting another such tool outfit, the job was given to a cutting-off machine and four engine lathes. The cost price of these five machines is much less than the cost of the turret lathe. Each simple lathe had a certain part of the work to do, and the pieces were passed from one machine to the other, giving results in every way superior to the results that had been considered so fine before. If one machine has trouble the others still keep cutting away, while with the turret lathe one little tool gone to the bad stops all cutting until it is fixed. I also know that I can stop that job, do something else, and start it up again at ten minutes' notice.

Another even more radical case is of a male and female right- and left-hand thread pipe coupling, made from seven-eighths-inch machine steel bar. These are used on water-tube boilers and to date about 80,000 have been produced. At first sight this seems to be an automatic screw-machine job pure and simple and, when the demand for the coupling was first felt, a thousand of them were ordered from a screw-machine company after comparing the quotations from four similar concerns. There was some delay in delivery so, as we had urgent need of three hundred, we made some ourselves and used three cheap 12-inch engine lathes. Our cost was so much below the automatic cost that they are still being made in that way, although salesmen are still highly elated at the chance to quote a price on them and assure the quietly smiling boss that they will take that tedious job off his hands.

Syracuse, N. Y. A. L. SPARKS.

Metal Goods in France

In answer to inquiries from the United States, Consul-General Robert P. Skinner, of Marseille, furnishes the following information concerning the outlook for American metal roofing, wire, and merchant iron and steel in France:

The outlook is very favorable for American metal goods in France, in spite of the rates of duty which tend to keep out all foreign metal goods and which fall with especial severity on American products, as the latter are subject to the maximum schedules. Upon imports of iron and steel American manufacturers must pay in France a rate of duty varying from 38.6 cents to $1.93 per 220 pounds more than is imposed on similar goods imported from other countries, and our manufacturers must overcome this first barrier to the extension of their business before proceeding further. While few foreign manufacturers of iron and steel are now doing business in France, there are times when they can do so, and they are always in a position, prices and qualities being equal, to share in the very considerable French export business to neutral markets, which is controlled by various wholesale firms in this country. The imports of iron of all classes into France in 1905 and 1906 were 17,632 tons and 26,351 tons, respectively. All but 527 and 400 tons, respectively, were imported from the United Kingdom. The imports in 1906 included the following in tons: Thin sheet iron, 4580; sheet iron more than 0.0234 inch in thickness, 1600; steel rails, 2571; steel wire, 3982; billets, 11,014; hot-rolled sheet steel, 2440; cold-rolled sheet steel, 715; fine tool steel, 2394; axles and tires, 734.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

During 1906 *the* AMERICAN MACHINIST *printed and circulated* 1,083,205 *copies, an average of* 20,832 *per issue. Of this issue* 19,000 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

Contents

PAGE

Master Plates and How They Are Made 927
Expansion and Contraction of Carbon Steel in Hardening 932
A Novel Crank-pin Turning Machine 933
Experiments With Graphite Lubrication 934
A Method of Broaching Tang Slots in Spindles 937
Universal Cam-cutting Machine 938
Apprentices and Skilled Workmen in England 940
Features of the Brown & Sharpe Foundry 941
Bearings of Woodworking Machines 944
Testing the Cutting Quality of Files 946
A Method of Making High-speed Cam Rollers 948
Practical Letters From Our Readers: Tricks in Selling Steel....Design for Bench Centers....Adjustable V-Blocks....Making Low-priced Impression Dies for Hard Rubber....Hollow Mills for Screw Machines....Winding a Helical Spring with Initial Tension....Horizontal Drilling Attachment for a Radial Drill....Jig for Drilling a Small Plate....Troubles of a Tool Designer....Casting Grooved Pulleys in a Two-part Mold....Thread Milling on the Speed Lathe....More About Chemical Analysis....Why is a Planer Bolted Down?....Fiber Friction Washers....A Plea for the Simple Lathe 949-959
Mathematics in Engineering Education 960
Are Scraped Bearing Surfaces Necessary? 960
Flow of Metals Under Pressure 961

Mathematics in Engineering Education

There has been a growing feeling for some time among teachers of engineering that the mathematical work given to engineering students is not upon a proper basis and that a change in methods is demanded. This idea found its first and, perhaps, its strongest voice, in the writings of Prof. John Perry, of one of the English technical schools. Professor Perry has written mathematical text-books on the lines which he advocates, and he has also read papers on the subject which were duly commented upon in our columns at the time of their appearance. The idea has now found strong root in this country, and in several of the engineering schools a change of program is under contemplation and, indeed, under way.

The idea at the bottom of the movement is that mathematics as taught does not have sufficient bearing upon the uses to be made of it by the student, either in his school work or his future life. There has been almost no adaptation of this kind, the subject being taught to engineering students as it is to those who study mathematics as a source of mental discipline or as a component part of a liberal education, or indeed to those who intend to make the subject a specialty. That is, the subject is treated as though it were in itself an end and not a means to an end; and it has resulted that many phases of the subject which have very little bearing on engineering have been dwelt upon to a disproportionate degree, whereas others of large practical application have received too little attention. The idea has been to develop the subject in a symmetrical manner from the mathematical standpoint, and not in a useful manner from the engineering standpoint. The giving of time to branches of the subject which have little application has, of course, reduced the time available for the useful branches, and especially has cut down the time available for drill, without which very few can acquire any considerable degree of independence in handling mathematics.

The matter has now reached a point where it is to be taken up in joint discussion by engineers and mathematicians, a portion of the program of the forthcoming meeting of the American Association for the Advancement of Science being such a discussion under the joint auspices of the mathematical and engineering sections of the association, and the Chicago section of the American Mathematical Society.

The movement has had our entire sympathy from the start, and it cannot fail to have useful results. There is no question that an engineer requires a thorough command of certain branches of mathematics, and there is just a little question that some of the branches taught in the engineering schools today are of the most limited use to him. By the cutting out of the latter and the expansion of the former, important results will unquestionably be secured.

Are Scraped Bearing Surfaces Necessary?

A scraped bearing means different things to different people. To most of us it means a bearing that has been planed or milled as accurately as possible and then scraped to a perfect fit, the high spots being carefully worked down so as to present a perfect bearing. A machine with an unscraped bearing would hardly be considered at all in making a purchase.

By scraping we mean the real fitting process which we have all revered for years, not the fancy frosted effect which some produce as a finish to attract the eye, regardless of the bearing itself.

But there are others to whom scraping has an entirely different meaning. To them it means poor planing or milling in the first place, an unnecessary expenditure of time and energy in the second, an expense that they cannot afford in the third, and lastly, a bearing that is not equal in any way to a good job of planing. The worst of it is that they seem to make their claims good.

We recently had the pleasure of seeing the planing department of a shop holding these heretical notions, and are free to confess we can hardly see how better planing is possible. The work varies from thin strips of tool steel to heavy castings, but the planing is of the best in both cases. The tool-steel strips are planed with a diamond-point tool, the finishing being done with the point slightly rounded or flattened to a large radius and a fine feed being used.

An interesting thing about this is that a finished piece of tool steel, planed in this way, presents the appearance of a finely grained piece of hard wood, due to the different degrees of hardness at various points in the surface. Different steels vary and require a different point on the tool for best results. High-speed steel is used for roughing, but not for finishing this fine work.

We immediately inquired if it would not be cheaper to rough plane these pieces and finish by grinding, or even to rough and finish on a good grinder; but their experience was not favorable to this plan. Nor was this due to prejudice against grinding, because they use grinders on some work and finish all shafting by rough turning and grinding. So it isn't lack of experience.

Going to the other extreme, we were shown several planers they had built for their own use, planers on which this

fine tool-steel planing was being done, and was assured that they never saw a scraper anywhere. The ways certainly had a bearing in all places that were visible as the table moved, and the work is good evidence that they were true.

They had also put a new cross rail on a large planer of standard make, and not a scraper mark appeared anywhere. Yet this was a long piece; the section was not symmetrical, and there was every chance for scraping being necessary if it ever is. On this same planer the ways had been scraped by the maker, and it was very evident that the table hit only in spots, as there were many scraper marks visible between the real bearing points in the ways. The remark that "It cost money to dig those holes with the scraper" fitted very nicely with the previous statement that they couldn't afford to scrape bearings, meaning that it was cheaper to plane them true in the first place than to have two operations.

It must not be supposed that the product of this shop is agricultural machinery or that close work is not done, for they build a class of machinery that requires the nicest kind of fitting, and no one has a better reputation in their line of work.

They go on the principle that a keen tool, held firmly in a fixed position, can produce a straighter and in every way truer surface than can be done by scraping a little here and a little more there; their work seems to bear out their contention.

If one shop finds that it can avoid scraping altogether, is it not possible that we are doing more than is necessary in many lines of work?

The Flow of Metals under Pressure

There seems to be a chance to formulate a new theory regarding the flow of metals under pressure, as some of those we are accustomed to do not seem entirely to cover the facts of the case.

This is brought out by the process of cold forming or squirting of tubes, as illustrated and described a few weeks ago in rather a startling manner. One would naturally suppose that in such an operation a slow, squeezing pressure would be far preferable, to give the metal time to flow or for the particles to readjust their relation to each other; but this does not seem to be the case at all. In fact, the best results seem to be obtained with a sudden pressure, such as a drop or a positive-stroke press; and when the press is used, it does better work at 120 than at 60 strokes a minute.

Another peculiar feature of the operation is the absence of excessive heat in the metal undergoing the punishment, for it can scarcely be called anything else to take a flat disk of metal and transform it into a tube in half a second. But the tube comes out comparatively cool and burnished with never more than a slight discoloration at the last end to come through the die. Of course some heat is generated, but not enough to change the color of the metal.

This is perhaps but a continuation of the controversy as to whether a drop hammer or a forming press is best for making duplicate forgings, but we would naturally expect the effect to be more marked in the case of cold metals than hot. That cold metal can change its shape so completely as in the case of squirting or extruding is wonderful in itself, but that this can be done better rapidly than slowly is very difficult to explain.

Personal*

Frank M. Ashley, formerly of the Ashley Engineering Company, has severed his connection with that company, and is now engaged in prosecuting patent work.

Reginald Trautschold, until recently connected with the Robins Conveying Belt Company, is now associated with the Intercontinental Engineering Company, New York, acting in the capacity of manager.

Harry E. Smith, previously engaged as head instructor, department of steam and machine design, Pratt Institute, Brooklyn, N. Y., now occupies the chair of professor of mechanical engineering at the James Miliken University, Decatur, Illinois.

G. W. Bissell, professor of mechanical engineering at the Iowa State College, Ames, Iowa, has recently assumed the position of dean of engineering and professor of mechanical engineering at the Michigan Agricultural College, East Lansing, Michigan.

S. Owen Livingston, for several years with the Fox Machine Company, has severed his connection with the firm and has become interested in the Wilmarth & Morman Company, Grand Rapids, Mich. Mr. Livingston is to take active charge of the publicity and selling departments of his new company.

H. R. Davis, formerly mechanical engineer with the Gorham Manufacturing Company, Providence, R. I., has recently associated himself with the Hope Engineering and Supply Company, gas engineers, Kansas City, Mo., doing a consulting and contracting business, specializing along natural-gas lines. Mr. Davis' new position is that of Western manager.

Thomas B. Davis, engineer with the Jeffrey Manufacturing Company, is no longer connected with that company, having recently accepted the position of chief engineer of the Cleveland Crane and Car Company, Wickliffe, Ohio. Mr. Davis' particular line of duty is in charge of the design of traveling cranes and electric and hand-power hoists.

*Items for this column are solicited.

Obituary

Charles P. Matthews, professor of electrical engineering at Purdue University, died at Phoenix, Arizona, on Saturday, November 23, 1907. Professor Matthews was of Vermont stock, his family going from that State to New York in 1852 where, at Fort Covington, he was born September 18, 1867. At the time of his death he was, therefore, a little more than forty years of age. He attended the St. Johnsbury Academy at St. Johnsbury, Vermont, graduating there in 1887. He then entered Cornell University, graduating from Sibley College with the degree of mechanical engineer, in 1892. In 1901, he received the degree of doctor of philosophy from his *alma mater*. Immediately after graduation, he became instructor in physics and applied electricity at Cornell, serving in that capacity four years, until 1896. At that time he was called to Purdue and was appointed associate professor of electrical engineering. In 1905 he succeeded Professor Goldsborough as head of the school of electrical engineering, and from this time until his death, he was continuously a member of the Purdue faculty. During Professor Matthews' connection with the school of electrical engineering, it has grown to be the largest in the country in point of numbers. In this development he has had a large share. His instruction was of the highest order not only on account of his professional ability and training, but quite as much on account of his exceptional personality and gifts. He made valuable contributions to his science, his chief work being an investigation of photometric standards for arc lamps. This was done in connection with the National Electric Light Association. In this, he directed all of the experimental work, designed the apparatus and prepared four reports aggregating about two hundred pages. In this connection he devised and patented an integrating photometer. This instrument received a gold medal at the Louisiana Purchase Exposition. He was also collaborator in the production of text books in physics and electricity with Professors Nichols and Shearer, of Cornell, and with Professor Esterline, of Purdue, and he had published a number of papers on electrical subjects. He was a member of the honor fraternity, Sigma Xi.

G. J. Humbert, the well known iron and steel manufacturer, died at his home, in Pittsburg, December 12. Mr. Humbert has always been specially associated with the tin-plate business, and when the Steel Corporation was formed his organization was one of those absorbed.

It is estimated that 55,000 automobiles will be built in this country next year, and figured on an average of $1000 per machine, $55,000,000 shows remarkable growth in a year's production of the automobile industry.

Ground Glass as a Substitute for Paper in Making Some Classes of Drawings

By W. E. Willis

I recently noticed a drawing device of such peculiar character and merit that a description may be of interest. We all know that at times it is desirable to reproduce old drawings, prints or sketches, and that the process of scaling, transferring sizes and redrawing will absorb almost as much time as was consumed in making the originals. Frequently some changes are to be made in these old drawings, which would prevent a photographic, or sun-print, copy from being used even if it were possible to make one; therefore a process for duplicating as much of the drawing as may be desired and which may be changed or have additions made is likely to be of interest, particularly as but small expense is involved in the apparatus and absolutely no material such as tracing paper or cloth, required.

In place of the wooden surface commonly used to fasten paper upon, the device consists of a frame having internally beveled edges and a plate of ground glass fitted to the frame in such manner that the ground or etched side is held level with the frame edges or slightly above it, so that ordinary T-squares and other tools may be manipulated as usual. The drawing to be reproduced is held tightly against the lower plain surface of the glass by cushions resting in turn on springs, so that an intimate contact may be obtained; the drawing is made directly on the ground surface of the glass.

Not only can the work be penciled, but it is found that ink lines may be made on the glass as readily as they can be made on paper and better than they can be made on most kinds of tracing cloth. Erasing is readily accomplished by the usual means; when the drawing has served its purpose, the surface can be thoroughly cleaned and renewed for other work. It is also found that excellent prints can be obtained by placing sensitized paper below the glass on the cushioned surface, previously used for the drawing to be traced. The drawing board is at that time converted into a blueprint frame, for which it is well adapted. In fact the device is so well liked that many original drawings have been made thereon, the ease in erasing, freedom from shrinkage and truly level surface of the glass being superior to the drawing boards commonly used.

In addition it may be said that contrary to the general, first impression, drawing tools do not wear more rapidly when used on the glass surface than when used on paper, as they merely touch the surface in leaving a trail of ink. In using compasses the fixed or stationary point is provided with a rubber button or pad, having a center and cross lines on its upper surface to be adjusted to the center lines intersecting in the circle to be drawn. While the combination is far from being new, as practically the same device has long been used by children in tracing familiar objects printed in black and placed under a transparent surface capable of receiving pencil marks, its use in a manufacturing establishment is a novelty, particularly the double use or that of making prints direct from drawings inked on its surface. It is suggested that by reversing the glass and making a negative print, that sharper lines might be obtained and the negative kept for possible further use, the same as an original drawing.

Business Items

W. E. Villinger, manufacturer of special machinery, models, dies and tools, has removed to larger and modern quarters at 711 First street, Williamsport, Penn.

The Turner Brass Works now report that they have completed the removal of the general offices and factory to Sycamore, Ill., and expect with the increased facilities to be in a better position to make prompt shipments.

Due to large increase during the past year in the sale of Thor pneumatic tools and appliances on the Pacific coast the Independent Pneumatic Tool Company has taken larger quarters at 61 Fremont street, San Francisco, Cal.

The Gardner Machine Company has recently opened a branch office in Cleveland, which is to be conducted in conjunction with Marcellus Reid, a well known mechanical engineer. The establishment of this new office has been the outgrowth of the large and steadily increasing central and eastern business of the company.

The Bury Compressor Company, Erie, Penn., has recently shipped one of its steam driven type of air compressors to the Brooklyn navy yard, and has an order from the Imperial Japanese navy for one 350-foot belt-driven air compressor. The navy department of France has also placed an order with it for a direct-connected motor-driven air compressor.

The Intercontinental Engineering Company, 126 Liberty street, New York City, formed a few months ago, has established connections in every country in Europe with headquarters at Paris. Its business is one of general engineering work, paying special attention to the design and equipment of power and industrial plants, conveying machinery, installations, and designing and erecting producer gas plants.

Manufacturers

The Atlanta (Ga.) Buggy Company, will erect a $25,000 building.

The Los Angeles (Cal.) Foundry Company will erect a new foundry.

The Remington Machine Company, Wilmington, Del., is erecting an addition.

The Walworth Run Foundry Company, Cleveland, Ohio, will erect a new building.

The New York Blower Company, Bucyrus, Ohio, is building an addition to its erecting room.

The Crawfordsville (Ind.) Wire and Nail Company is erecting an addition to its factory.

The Midland Electric Company, Des Moines, Iowa, will erect a new $25,000 building.

The Rodgers Boiler and Burner Company, Muskegon, Mich., will build an addition to its plant.

The Wisconsin Knitting Mills Company, Manitowoc, Wis., will double the capacity of its plant.

The carriage factory of the I. A. Shannon Estate, Bay City, Mich., recently burned, will be rebuilt.

Fire in the power house of the Pittsburg (Penn.) Malleable Iron Company caused a loss of $15,000.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, Amer. Machinist.

Automatic machinery designed and built. G. M. Mayer, 1461 Monadnock Blk., Chicago.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machinery, tools and fixtures designed; ideas developed, drawings made. Box 1264, Paterson, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machinery Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Mechanics, write for our special offer of how to get a set of wrenches free. Bullard Automatic Wrench Co., Providence, R. I.

Wanted—The following second-hand machinery; one forging machine, two turret lathes, one bolt cutter, one 24"x16' engine lathe. Box 687, American Machinist.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, Amer. Machinist.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Mechanical engineer, experienced in selling, designing, and superintending the construction and installation of passenger and freight elevators desires to correspond with concern having facilities for manufacturing. Box 679, American Machinist.

Special machinery and duplicate machine

parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Shop committees; I would like to get the addresses of firms manufacturing machinery or kindred articles, whose business management is partly or wholly determined by a shop committee acting in conjunction with officers of the company. "Efficiency," Box 703, AMERICAN MACHINIST.

Machine work wanted; manufacturing company conveniently located in middle west with good shipping facilities, large new machine shop equipped with modern labor saving tools driven by individual variable speed motors, full complement traveling cranes, has surplus capacity, and would like an opportunity of figuring on machine work of any class from 16' diameter down; prepared to do machining alone or to furnish either steel or iron castings completely machined to gauge. Box 697, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Position as chief engineer, or in charge of maintenance and repairs in industrial plant; have had experience in direct and alternating current power stations, machine shop, arc and incandescent lighting, motors, wiring and compressed air; not a technical graduate, but have had wide practical experience in above lines and especially steam engine repairing, both Corliss and high speed; can figure all problems met in practice, understand indicators, valve setting, horizontal tubular and water tube boilers, and mechanical drawing; at present employed, but desire to change. Box 685, AMERICAN MACHINIST.

ILLINOIS

Assistant superintendent of a Connecticut factory wishes to locate in or near Chicago; three years in present position and five years' previous experience in drafting room and machine shop; 32 years old; graduate of Yale; junior member A. S. M. E. Box 686, AMERICAN MACHINIST.

MASSACHUSETTS

Superintendent of manufacturing plant open for engagement, either supervision or designing. Box 671, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer; first-class machinist; a technical graduate with six years' machine shop experience, and six years' drawing room experience, having good executive ability and can give good reference, desires a change; wants position in full charge of experimental work or as superintendent of plant. Box 705, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 711, AMERICAN MACHINIST.

Young man with 3 years' shop experience wishes position as detail draftsman. Box 701, AMERICAN MACHINIST.

Mechanical draftsman; 6 years of practical experience wants a position in New York, New Jersey or Connecticut. Box 662, AMERICAN MACHINIST.

Situation wanted by a designing draftsman several years' experience in Corliss steam engines, air compressors and rock drills; A-1 references. Box 707, AMERICAN MACHINIST.

Machine designer, technically educated, having 9 years' shop and drafting room experience; versed in latest factory, cost and specification systems, desires position. Box 682, AMERICAN MACHINIST.

Factory manager and organizer, cost expert and systematizer, experienced, practical man who can prove by past record ability to make good; will be disengaged Jan. 1, '08. Box 692, AMERICAN MACHINIST.

Superintendent; experienced in office, drafting room, pattern, foundry and machine shop; capable of successfully handling large force of men, reducing costs, and increasing production. Box 688, AMERICAN MACHINIST.

Young man; 23; 4 years' drafting experience, 1 year in superintendent's office of present employer; factory employs 1700 hands; desires position with novelty or hardware manufacturers. Box 706, AMER. MACH.

Superintendent of large manufacturing and engineering establishment desires change; location, Greater New York or vicinity; superior executive and inventive ability and wide experience; light, medium or heavy manufacturing; expert on tool, jig, fixture and special machine design; thoroughly up in modern shop practice and system; accustomed to handling successfully large numbers of men; permanent; reasonable salary. Address Box 696, AMERICAN MACHINIST.

OHIO

Foreman, 12 years' experience in chucking and screw machine department; accustomed to accurate work; can produce results; references. Box 700, AMERICAN MACHINIST.

PENNSYLVANIA

Practical machine shop engineer thoroughly familiar with steam and gas engines and all kinds of medium automatic machinery, desires position as plant engineer or designer of special machines and fixtures for reducing cost of production; at present superintendent of shops; best results insured; references A-1; salary $2400. Box 699, AM. M.

RHODE ISLAND

Position of trust or responsibility by experienced machinery executive office man; correspondent, systematizer, exact, thorough; go anywhere. Box 76, Pawtucket, R. I.

Reliable designer of special machinery, tools, jigs, fixtures, experimental work, steam turbines, knowledge of shop foundry, patterns; married; age 34. Box 708, AM. M.

Help Wanted

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS

Wanted—Foreman for tool department, competent to take charge of machine tool repairs, new tools and fixtures for economical production, and familiar with up to date shop products; factory located in New England with the best conditions. Box 704, AM. M.

Toolroom foreman wanted; a thoroughly experienced energetic foreman who has had charge of tool making and tool supply and issue with high-grade concerns manufacturing miscellaneous metal goods on a large scale; must be able to handle men efficiently, and turn out first class work with rapidity; old established concern in vicinity of Boston; open shop. Box 709, AMERICAN MACHINIST.

MICHIGAN

Opportunity for ambitious machinists to become foremen; advertiser wants several such men to act now as inspectors of parts used in building automobiles, and to become foremen when fitness for such position is proved; open shop; small atractive town. Address Box 647, AMERICAN MACHINIST.

MISSOURI

Wanted—One first-class machine blacksmith on job work who can get out work with steam hammer; steady work and good wages to a good sober man; open shop. Address Hugh Mathews, Kansas City, Mo.

NEW YORK

Designer, expert on all kinds of tool work, competent to take charge of designing and drafting department of 30 men. Write stating age, experience and salary expected to F. E. I., 41 West 34th Street.

A thorough experienced mechanic can secure good position and be an officer in an organized automobile accessory concern if he will invest $2500 to $4000 as a loan or interest in company. Box 710, AMER. MACH.

Wanted—Machinery designer, thoroughly experienced with presses and other machinery for sheet metals, and competent to take the lead in our drafting room; good salary to the right man; please state experience, etc. Niagara Machine and Tool Works, Buffalo, N. Y.

Wanted—An experienced draftsman of both mechanical and structural architectural drawing for a technical school; permanent position for first-class man. Apply by letter stating qualifications and experience in full, to Instruction Committee, P. O. Box 37, Station D, New York.

Toolmaker; A-1 practical mechanic experienced in the manufacturing of tools in all its branches and having experience in handling a large force of men; none but a man with such experience need apply; write stating age, experience and salary expected. "H. S. P.," 41 W. 34th St., New York.

OHIO

Top notch foundry superintendent wanted at once for new machine-molding gray iron foundry; the various buildings and equipment just being completed; strictly up-to-date including continuous pouring; applicant must be temperate in habits, of good character, aggressive, and above all, a good executive; full knowledge of molding machines and best application of patterns thereto absolutely necessary; give full particulars, references, where employed at present, and state salary required; all communications treated confidentially; no cheap man need apply. Address The Cincinnati Milling Machine Co., Cincinnati, Ohio.

Wanted—Milling machine foreman for commercial milling, to take charge of 20 men. Box 684, AMERICAN MACHINIST.

WEST VIRGINIA

Wanted—Several first-class machinists for marine engine work. The Charles Ward Engineering Works, Charleston, W. Va.

WISCONSIN

A first-class designer, with executive ability to take full charge of a shop employing from 30 to 50 men on small specialties; past accomplishments will be test of fitness; give references and salary expected. Box 702, AMERICAN MACHINIST.

FOREIGN

First-class machine tool fitters and turners leaving the States can apply to John Holroyd & Co., Ltd., near Rochdale, Lancashire, England, for situations.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Turret punch press patent No. 852,443 dated May 7, 1907, on page 883 of the American Machinist for December 5, 1907, is for sale. F. G. Marbach, Medina, Ohio.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—Complete copies of American Machinist from date of its first publication, Nov., 1877, to the present time. Address J. W. Chamberlain, 443 East Market St., Akron, Ohio.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	100
Acme Machinery Co.	106
Adams Co.	69
Adjustable Collet Co.	80
Albro-Clem Elevator Co.	102
Almond Mfg. Co., T. R.	78
Alteneder & Son, Theo.	81
American Emery Wheel Wks.	100
American Gas Furnace Co.	59
American Pulley Co.	83
American Tool & Mach. Co.	71
American Tool Wks. Co.,	8 and 111
American Tube & Stamping Co.	113
American Watch Tool Co.	105
American Wood Working Mchy. Co.	71
Ames & Co., B. C.	74
Armsrong-Blum Mfg. Co.	76
Armstrong Bros. Tool Co.	68
Athol Machine Co.	85
Automatic Machine Co.	63
Backus Water Motor Co.	94
Baker Bros.	67
Baldwin Chain & Mfg. Co.	76
Baldwin Steel Co.	47
Bardons & Oliver	64
Barnes Co., B. F.	25
Barnes Co., W. F. & John	14
Barnett, G. & H.	38
Bath Grinder Co., Inc.	101
Baush Machine Tool Co., 3d cover	
Bay State Stamping Co.	109
Beaman & Smith	15 and 78
Becker-Brainard Milling Machine Co.	23
Bemis & Call Hardware & Tool Co.	69
Besly & Co., Chas. H.	108
Bethlehem Fdry. & Mach. Co.	71
Bethlehem Steel Co.	87
Bickford Drill & Tool Co.	10
Bignall & Keeler Mfg. Co.	75
Bilgram, Hugo.	102
Billings & Spencer Co.	57
Binsse Machine Co.	38
Birdsboro Steel Fdry. & Mach. Co.	66
Blaisdell Machinery Co.	94
Blanchard Machine Co.	70
Bliss Co., E. W.	25

	PAGE
Blount Co., J. G.	32
Boston Gear Wks.	102
Bowsher Co., N. P.	76
Box & Co., Alfred	82
Boynton & Plummer	66
Bradford Machine Tool Co.	5
Bridgeport Safety Emery Wheel Co.	100
Bristol Co.	4th cover
Bristol, Wm. H.	38
Brown Co., H. B.	74
Brown & Co., R. H.	79
Brown & Sharpe Mfg. Co.	4th cover
Brown Hoisting Mchry. Co.	82
Brubaker & Bros., W. L.	76
Brunswick Refrigerating Co.	70
Bullard Auto. Wrench Co.	68
Bullard Mach. Tool Co.	37
Burke Electric Co.	92
Burr & Son, John T.	74
Burroughs Co., Chas.	70
Bury Compressor Works	94
Butterfield & Co.	66
C & C Electric Co.	91
Caldwell & Son Co., H. W.	112
Cammel Laird & Co.	87
Carborundum Co.	27
Card Mfg. Co., S. W.	14
Carpenter Tap & Die Co., J. M.	72
Carr & Co., Stuart R.	87
Carver File Co.	109
Case Mfg. Co.	82
Cell Drier Machine Co.	89
Chadwick & Trefethen	75
Chambersburg Engineering Co.	107
Champion Tool Works	75
Chicago Flexible Shaft Co.	106
Chicago Pneumatic Tool Co.	95
Chicago Raw Hide Mfg. Co.	77
Cincinnati Elec. Tool Co.	62
Cincinnati Machine Tool Co.	89
Cincinnati Milling Machine Co.	6 and 7
Cincinnati Planer Co.	24
Cincinnati Shaper Co.	114
Clark, Jr., Elec. Co., Jas.	91
Clark Cast Steel Ceemnt Co.	109
Clark Auto. Telephone Switchboard Co.	113
Clayton Air Compressor Wks.	94
Cleveland Auto. Mach. Co.	18
Cleveland Cap Screw Co.	74
Cleveland Crane & Car Co.	82
Cleveland Planer Wks.	109
Cleveland Twist Drill Co.	4th cover
Cleveland Wire Spring Co.	107
Clough, R. M.	103
Coates Clipper Mfg. Co.	99
Coes Wrench Co.	16
Colburn Machine Tool Co.	32
Cook Co., Asa S.	76
Consolidated Press & Tool Co.	104
Cowanesque Valley Iron Wks.	83
Crescent Forgings Co.	68
Crocker-Wheeler Co.	92
Crosby Steam Gage & Valve Co.	17
Curtis & Co. Mfg. Co.	94
Curtis & Curtis Co.	101
Cushman Chuck Co.	78
Davis Machine Co., W. P.	109
Desmond-Stephan Mfg. Co.	101
Detrick & Harvey Mach. Co.	75
Diamond Chain & Mfg. Co.	77
Dill Slotter People	105
Dixon Crucible Co., Jos.	84
Dreses Machine Tool Co.	30
Earle Gear & Mach. Co.	102
Eastern Machinery Co.	74
Eberhardt Bros. Mach. Co.	102
Eck Dynamo and Motor Co.	92
Elmes Engineering Works, Chas. F.	77
Emmert Mfg. Co.	84
Errington, F. A.	79
Evans Friction Cone Co.	62
Excelsior Needle Co.	72
Farrel Fdry. & Machine Co.	87
Fawcus Machine Co.	102
Fay Machine Tool Co.	32
Fellows Gear Shaper Co.	57
Felton, Sibley & Co.	71
Ferracute Machine Co.	75
Firth-Sterling Steel Co.	88
Fitchburg Machine Wks.	31
Flather Planer Co., Mark.	81
Foote Bros. Gear & Mach. Co.	103
Foote-Burt Co., The	76
Fosdick Machine Tool Co.	16
Franklin Mfg. Co., H. H.	86
Franklin Port. Crane & Hoist Co.	82
Gang Co., Wm. E.	76
Gardner Machine Co.	101
Garvin Machine Co.	103
Gem Mfg. Co.	83
General Electric Co.	90
General Pneumatic Tool Co.	83
Geometric Tool Co.	21
Gisholt Machine Co.	114
Gleason Works	4th cover
Globe Machine & Stamping Co.	76
Goldschmidt Thermit Co.	87
Goodell-Pratt Co.	80
Gorton Machine Co., Geo.	70
Gould & Eberhardt	76
Graham Mfg. Co.	84
Grant Gear Wks.	102
Grant Mfg. and Machine Co.	106
Gray Co., G. A.	20
Gray & Prior Machine Co.,	72 and 107
Greaves, Klusman & Co.	73
Gronkvist Drill Chuck Co.,	69 and 78
Hammacher, Schlemmer Co.	51
Hanna Engineering Wks.	76
Hardinge Bros.	74
Harrison & Knight Mfg. Co.	77
Harrington, Son & Co., Edw.	69
Hart & Cooley Co.	65
Hebert Sales Co., J. R.	82
Hendey Machine Co.	53
Henley Pub. Co., Norman W.	25
Henry & Wright Mfg. Co.	65
High Duty Saw & Tool Co.	105
Hill, Clarke & Co., Inc.	111
Hill Publishing Co.	38 and 108
Hisey-Wolf Machine Co.	25
Hoefer Mfg. Co.	89
Hoggson & Pettis Mfg. Co.	78
Horsburgh & Scott Co.	102
Horton & Son Co., E.	78
Hunt Co., Robt. W.	74
Hurlbut-Rogers Machine Co.	65
Industrial Oxygen Co.	87
Ingersoll Milling Machine Co.	64
Ingersoll-Rand Co.	95
Jacobs Mfg. Co.	79
Jantz & Leist Elec. Co.	92
Jenkins Bros.	77
Johnson Machine Co., Carlyle	45
Jones & Lamson Mach. Co.,	12, 13 and 38
Juengst & Sons, George	67
Kearney & Trecker	107
Kelly Co., R. A.	73
Kempsmith Mfg. Co.	22
Kern Machine Tool Co.	113
Keuffel & Esser Co.	81
Keystone Steel Castings Co.	86
Knight Machinery Co., W. B.	106
Kolesch & Co.	81
L. & D. Co.	75
Landis Machine Co.	107
Landis Tool Co.	47
Lapointe Machine Tool Co.	70
Lea Equipment Co.	30
LeBlond Machine Tool Co., R. K.	45 and 4th cover
LeCount, Wm. G.	81
Leonard Mfg. Co.	75
Link Belt Co.	98
Lodge & Shipley Machine Tool Co.	4
Long & Allstater Co.	73
Lucas Machine Tool Co.	112
Lumen Bearing Co.	86
Lunkenheimer Co.	84
Lyon Metallic Mfg. Co.	106
Macdonald & Macdonald	74
Manning, Maxwell & Moore, Inc.	96 and 97
Manufacturers Equipment and Engineering Co.	94
Manville Bros. Co.	17
Maris Bros.	82
Marshall & Huschart Mch. Co.	111
Mass. Saw Works	77
McCabe, J. J.	64 and 110
Merritt, Jos.	107
Merritt & Co.	74
Metal Hardening Solution Co.	86
Millers Falls Co.	70
Milton Mfg. Co.	51
Miner & Peck Mfg. Co.	75
Mittineague Paper Co.	81
Monarch Emery & Cor. Wheel Co.	100
Moore Co., Franklin	83
Morris Foundry Co., John B.	9
Morse Chain Co.	1 and 65
Morse Twist Drill & Mach. Co.	49
Morse, Williams & Co.	103
Morton & Co., B. K.	87
Morton Mfg. Co.	74
Mossberg Wrench Co.	74
Motch & Merryweather Machine Co.	109
Mueller Mach. Tool Co.	63
Mumford Co., E. H.	76
Mummert, Wolf & Dixon Co.	71
Mutual Machine Co.	75
National Acme Mfg. Co.	114
National Machine & Tool Co.	76
National Machinery Co.	75
New Britain Mach. Co.	63
New Haven Mfg. Co.	71
New Process Raw Hide Co.	103
Newton Machine Tool Wks.	11
Nicholls, Wm. S.	82
Nicholson File Co.	17
Nicholson & Co., W. H.	70
Niles-Bement-Pond Co.,	2, 3, 33, 36 and 110
Northern Elec. Mfg. Co.	90
Northern Engineering Works	82
Norton Co.	61
Norton Grinding Co.	60
Nuttall Co., R. D.	102
Obermayer Co., S.	87
O. K. Tool Holder Co.	70
Owen Mach. Tool Co.	22
Parker Company, Chas.	85
Patterson, Gottfried & Hunter, Ltd.	77
Pawling & Harnischfeger	82
Paxson Co., J. W.	77
Philadelphia Bourse	66
Philadelphia Gear Works	102
Pittsburg Auto. Vise & Tool Co.	85
Potter & Johnston Mach. Co.	53
Pratt Chuck Co.	78
Pratt & Whitney Co.	34 and 35
Prentice Bros. Co.	29
Prentiss Tool & Supply Co.,	109 and 110
Queen City Machine Tool Co.	75
Reece Co., E. F.	76
Reed Co., F. E.	28
Reed Mfg. Co.	84
Reichhelm & Co., E. P.	73
Ridgway Dynamo & Engine Co.	92
Risdon Tool Works	75
Rivett-Dock Co.	3d cover
Rivett Lathe Mfg. Co.	3d cover
Rock Island Tool Co.	85
Rockwood Mfg. Co.	82
Rogers & Hubbard Co.	86
Rogers Wks., John M.	72
Roth Bros. & Co.	92
Rowell Co., W. G.	87
Royersford Fdry. & Mach. Co.	73
Safety Emery Wheel Co.	100
Saunders Sons, D.	72
Sawyer Gear Wks.	102
Schieren & Co., Chas. A.	94
Schmitz, August	73
Schreiber & Beuster	109
Schumacher & Boye	9
Schwerdtle Stamp Co.	75
Seaver, John W.	72
Sebastian Lathe Co.	67
Sellers & Co., Inc., Wm.	26
Seneca Falls Mfg. Co.	68
Shelby Steel Tube Co.	86
Shultz Belting Co.	77
Sibley Mch. Tool Co.	73
Skinner Chuck Co.	78
Slate Machine Co., Dwight	71
Sloan & Chace Mfg. Co.	104
Slocomb Co., J. T.	89
Smith Countershaft Co.	31
Smith & Mills	76
Smith & Post Co.	106
Smith Co., Wm. J.	21
Spacke Mach. Co., F. W.	95
Sprague Electric Co.	93
Springfield Mach. Tool Co.	15
Standard Connecting Rod Co.	84
Standard Engineering Works	74
Standard Gauge Steel Co.	103
Standard Tool Co.	80
Stark Tool Co.	74
Starrett Co., L. S.	99
Stoever Foundry & Mfg. Co.	62
Struthers-Wells Co.	84
Sturtevant Co., B. F.	20
Tabor Mfg. Co.	63
Taylor & Fenn Co.	72
Taylor-Wilson Mfg. Co.	102
Technical Supply Co.	81
Thompson, Hugh L.	77
Toomey, Frank	109
Triumph Electric Co.	92
Tudor Mfg. Co.	107
Turner Brass Works	74
Underwood & Co., H. B.	107
Union Mfg. Co.	78
Union Twist Drill Co.	55
Universal Machine Screw Co.	67
U. S. Electrical Tool Co.	92
Van Dorn & Dutton	102
Vandyck Churchill Co.	30
Veeder Mfg. Co.	81
Vitrified Wheel Co.	101
Von Wyck Mach. Tool Co.	71
Wagner Elec. Mfg. Co.	92
Walcott & Wood Mach. Tool Co.	77
Wallace Supply Co.	75
Waltham Machine Works	75
Waltham Watch Tool Co.	62
Ward & Sons, Edgar T.	88
Warner & Swasey Co.	112
Warner Instrument Co.	72
Waterbury Farrel Fdry. & Mach. Co.	77
Waterbury Gear Co.	103
Watson-Stillman Co.	98
Wellman Co.	75
Wells Bros. Co.	64
Wells & Son Co., F. E.	59
Western Electric Co.	90
West Haven Mfg. Co.	77
Westinghouse Elec. Mfg. Co.	91
Westmacott Gas Furnace Co.	74
Weston Elec. Instrument Co.	94
Whitcomb-Blaisdell Mach. Tool Co.	19
Whitman & Barnes Mfg. Co.	104
Whitney Mfg. Co.	43
Whiton Machine Co., D. E.	79
Wiley & Russell Mfg. Co.	106
Williams & Co., J. H.	73
Williamson Vise Co.	85
Wilmarth & Morman Co.	100
Winkley Co.	94
Wood's Sons Co., T. B.	83
Woodward & Powell Planer Co.	28
Worcester Machine Screw Co.	74
Wormer Machinery Co., C. C.	111
Wrigley Co., Thos.	101
Wyke & Co., J.	77

Classified Index to Articles Advertised

Abrasive Materials

Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.

Abrasive Materials—*Cont.*

Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bethlehem Foundry and Machine Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Keuffel & Esser Co., New York.

Blue Print Paper

Keuffel & Esser Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Phila., Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.

Boring and Drilling Machines, Horizontal—*Cont.*

Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Carr & Co., Stuart R., Baltimore, Md.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Core

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Cell Drier Machine Co., Taunton, Mass.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Hebert Sales Co., New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Mossberg Wrench Co., Central Falls, R. I.

Countershafts—*Continued.*

Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Crank Pin Turning Machines

Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Manning, Maxwell & Moore, Inc., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Manville Bros. Co., Waterbury, Conn.
Risdon Tool Works, Waterbury, Conn.

Dies, Sub-Press

Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

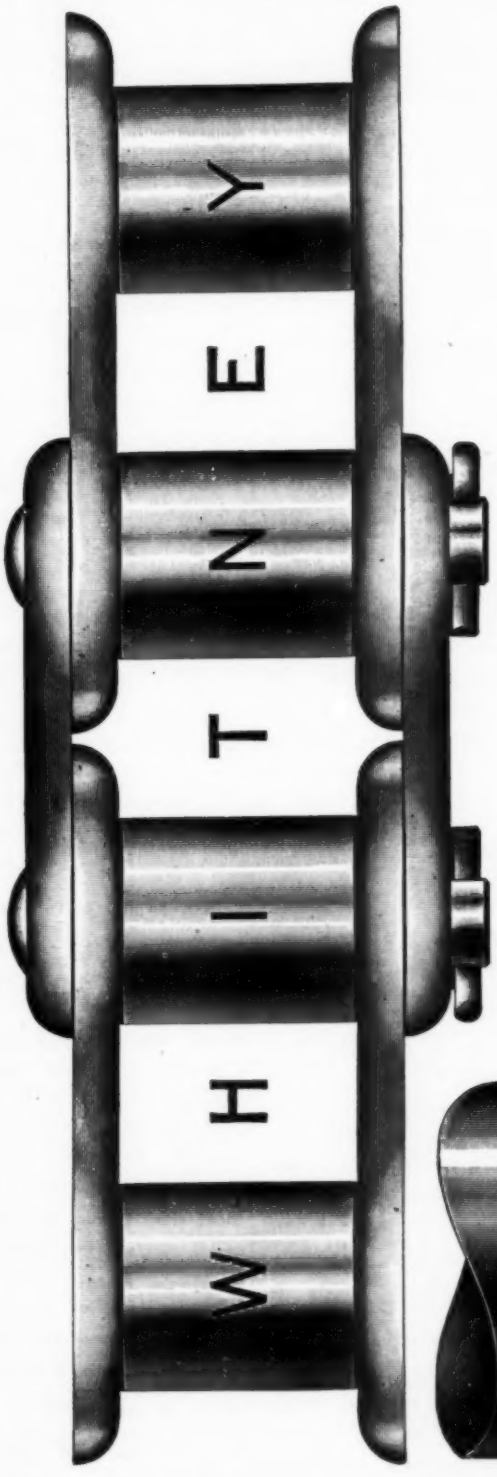
Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Ideal Opening Die Co., New York.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

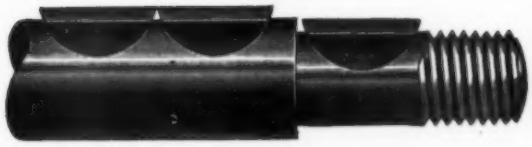
"WHITNEY" CHAINS

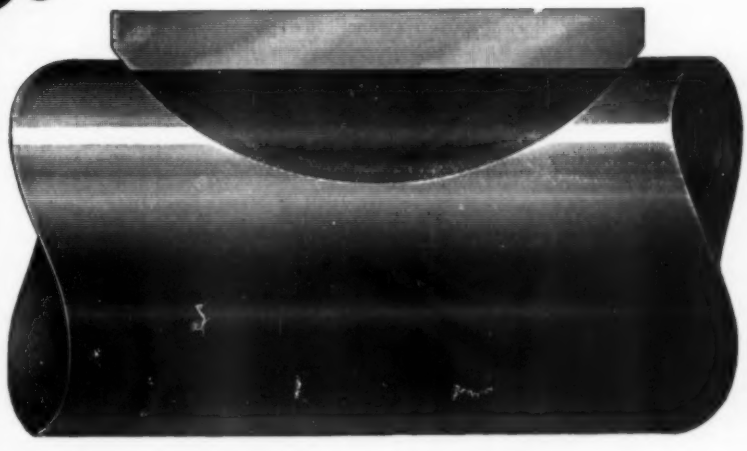
Hand (feed) Milling Machines

The Woodruff Patent System of Keying



The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, O.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Smith, M. A., Providence, R. I.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Andrews & Co., M. L., Cincinnati, Ohio.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Cincinnati Pulley Machry. Co., Cincinnati, Ohio.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Drilling Machines, Upright —*Continued.*

Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Manning, Maxwell & Moore, Inc., New York.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
Eck Dynamo and Motor Co., Belleville, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.

Electrical Supplies —*Continued.*

Western Electric Co., Chicago, Ill.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Manning, Maxwell & Moore, Inc., New York.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineer, Consulting and Architect

Thompson, Hugh L., Waterbury, Conn.

Engineers, Mechanical and Electrical

Crocker - Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Jackson, Henry Docker, Boston, Mass.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam

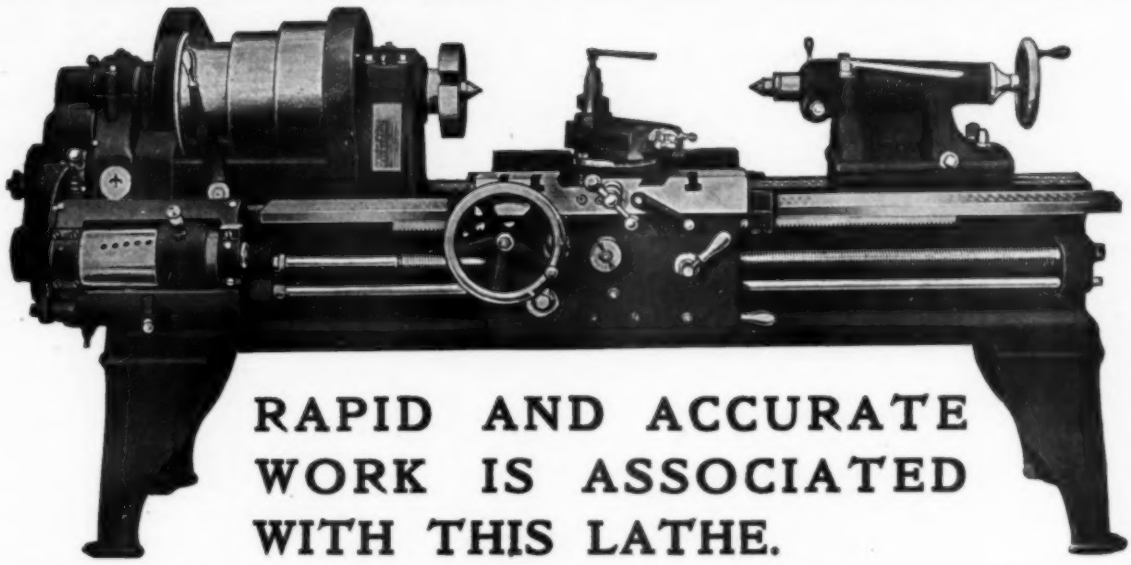
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.



RAPID AND ACCURATE WORK IS ASSOCIATED WITH THIS LATHE.

Here's the lathe that always goes hand in hand with profits. Wherever you find one, you'll find the other. For the LeBlond Double Friction Back-geared, High-speed Lathe is a Lathe peculiarly different from and far above the great majority. It is designed for executing high class work and to successfully solve modern tool-steel problems.

Write for a detailed account of its superior features.

The R. K. LeBlond Machine Tool Company, 4620 Eastern Ave., CINCINNATI, OHIO

Niles-Bement-Pond Co., Agents. L. Booth & Sons, Los Angeles, Cal. Bailey-Smith Machinery Co., Sole Agents for San Francisco. Germany: de Fries & Cie., Akt. Ges., Dusseldorf, Berlin, Stuttgart. Italy: de Fries e. C., Corso Principe Umberto, Angolo Via Moscova, Milan. France: de Fries & Cie., 19 Rue de Rocroy, Paris. Spain: de Fries y Cia., 660 Calle de las Cortes, Barcelona. J. Lambercier & Co., Geneva, Switzerland.

THE JOHNSON FRICTION CLUTCH

SECTION BROKEN AWAY, SHOWING CLUTCH DISENGAGED

IS BEING ADOPTED BY LEADING MANUFACTURERS AND TOOL BUILDERS AS A NECESSARY PART OF MACHINES.

Because the use of high speed steels has become necessary, more powerful clutches are required. To meet all the needs of modern machinery the Johnson Friction Clutch was designed, and its present perfection is proved by its almost universal use. ¶The "Johnson" has won out because it is simple (see lower illustration), powerful, compact and neat; because it operates quietly and perfectly at any speed; because it has no projecting parts, no bolts, nuts, links, etc., to cause trouble; because it is dirt and dust proof; because it runs without vibration.

¶If you see the importance of having perfect clutches it's your cue to investigate the "Johnson". Ask for the booklet.

JOHNSON FRICTION CLUTCH DIS-ASSEMBLED NOTE THE FEW PARTS.

FOREIGN AGENTS—Efandem Co., 67a Shaftsbury Ave., London, Eng., for Great Britain. Canadian Fairbanks Co., Montreal, Toronto, Winnipeg and Vancouver, for Canada. H. Glaenzer & Perreaud, No. 1 Avenue de la Republique, Paris, for France. Bieberstein & Goedicke, Ferdinanstr, No. 25—7 Amerikahaus, Hamburg, for Germany. Wilh. Sonneson & Co., Malmo, Sweden, for Norway, Sweden, Finland and Denmark.

THE CARLYLE JOHNSON MACHINE CO. HARTFORD CONN.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Manning, Maxwell & Moore, Inc., New York.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Ames & Co., B. C., Waltham, Mass.
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.

Gear Cutting Machinery —*Continued.*

Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn,
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Morse, Williams & Co., Phila., Pa.
Mutual Machine Co., Hartford, Conn.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, Ohio.

Gears, Worm —*Continued.*

Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Knife

American Wood Working Mchy. Co., Rochester, N. Y.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Manning, Maxwell & Moore, Inc., New York.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter

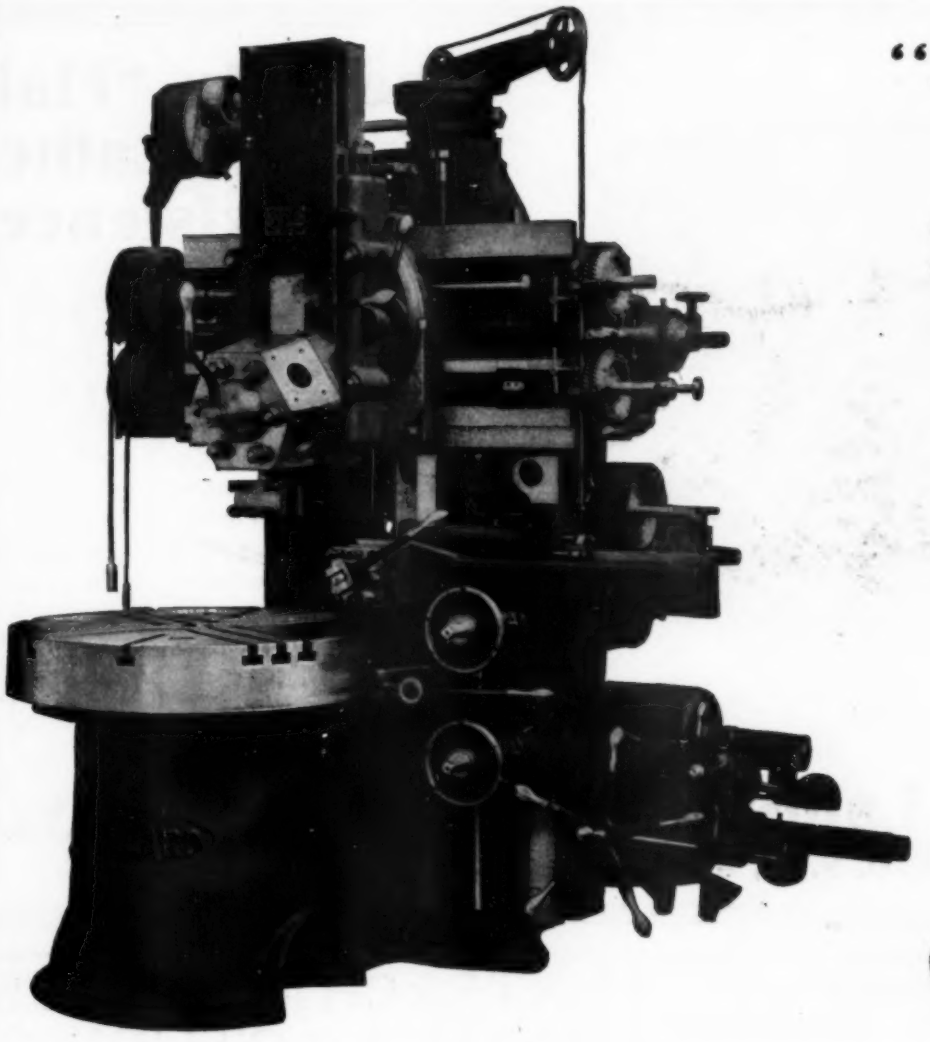
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Dock Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk

Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.



"A Multi-Purpose Machine Tool."

THE BULLARD

VERTICAL TURRET LATHE

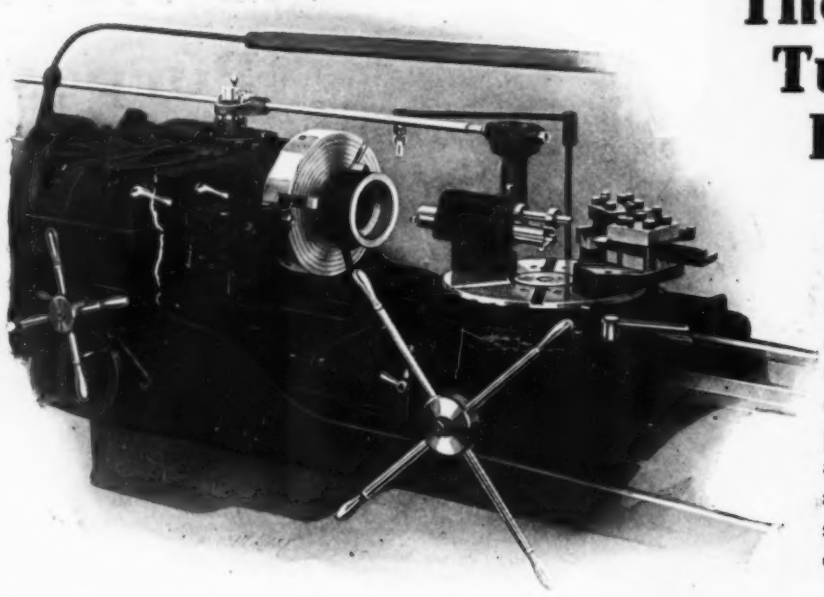
combines the valuable features of horizontal turret lathe and vertical boring and turning mill in such a way that all manner of face plate work is handled with perfect accuracy, increased speed and minimum effort.

In many cases heavy, awkward pieces can be chucked and finished before they could be made ready on a horizontal turret lathe. The remarkable performances of this tool are worth your thorough investigation.

ASK FOR OUR CATALOG 30.

The Bullard Machine Tool Co. BRIDGEPORT, CONN., U.S.A.

AGENTS—Marshall & Huschart Machinery Co., Chicago, Ill. The Motch & Merryweather Machinery Co., Cleveland, O. Chas. G. Smith Co., Pittsburg, Pa. C. H. Wood Co., Syracuse, N. Y. Pacific Tool & Supply Co., 556 Howard Street, San Francisco, Cal. Williams & Wilson, Montreal, P. Q. Chas. Churchill & Co., Ltd., London, E. C., England. Fenwick Freres & Co., Paris, France. Heinrich Dreyer, Berlin, Germany. Landre & Glinderman, Amsterdam, Holland.



The Only "Flat Turret" Lathe In Existence

The turret is a flat circular plate mounted on a low carriage containing controlling mechanism. Connections are direct and rigid, affording absolute control of cutting tools. Index pin is located directly under working tool to prevent lost motion between tool and locking pin. A simple, accurate stop mechanism for the turret slide provides twelve independently adjustable stops.

This Turret construction is only one of the advantages of the "Flat Turret." See pages 12 and 13 of this issue for further particulars.

Jones & Lamson Machine Company,

Springfield, Vt., U. S. A., and 97 Queen Victoria St., London, E. C.

Accurate and Rapid Boring

BINSSE BORING MACHINES

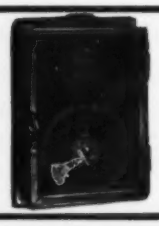
ALL SIZES

THE BINSSE MACHINE COMPANY,
Newark, N. J.

WM. H. BRISTOL,
ELECTRIC PYROMETERS.

RECORDING OR INDICATING FOR HARDENING, TEMPERING AND ANNEALING, ETC. PRACTICAL FOR EVERY DAY SHOP SERVICE Fully Guaranteed. Send for Circulars.

WM. H. BRISTOL,
45 Vesey St., New York.



Black Diamond Files and Rasps

PERFECT ALWAYS

Twelve Medals Awarded at International Expositions

For Sale Everywhere

Copy of Catalog will be sent free to any interested file user on application

G. & H. BARNETT CO., Phila., Pa.

INTERCHANGEABLE MANUFACTURING

The importance of this work is generally recognized now, but few firms have made exhaustive studies of the economy which can be introduced.

We have started a series devoted to this end. The first book is

GRINDING AND LAPPING

It is a complete study of the best grinding and lapping processes—practical in its treatment but the kind of a practical book that we believe in—practical because it is sound scientifically and yet simple in statement. Another, in press now, is

GAGES AND GAGING SYSTEMS

Here again is a very important phase of the work. The average boss would be appalled at the waste in his shop from ignorance of accurate gage methods.

The books are both by JOSEPH V. WOODWORTH

They cost $2 apiece. You can get the first one now and the other in January.

Order both now.

Send for our 168-page Book Catalog.

HILL PUBLISHING COMPANY
505 PEARL STREET NEW YORK

A Precision Drilling and Reaming Machine*

A Machine for Laying Out and Drilling Work on a Drill Press so Each Piece Will Be an Exact Fit With Many Others

EDITORIAL CORRESPONDENCE

The method herein described and illustrated is that used by the Burroughs Adding Machine Company, of Detroit, Mich., in its experimental room. It has been developed and adopted, after many years of experience, as the best and quickest method of getting out the different parts when some improvement makes it necessary to alter or redesign the machine. This policy of improvement is very important in the case of the Burroughs as well as all other adding machines, as is forcibly demonstrated by visiting the historical fire-proof vault in which is a model of every different machine which has been built, from the original Burroughs to the present one. The progress shown is truly wonderful.

*Copyright, 1907, by Hill Publishing Company.

Drafting

As in all well regulated manufacturing plants, the ideas originating in the brains of its inventors are first worked out and put on paper by a corps of draftsmen.

In this case a vertical line is placed on the drawing paper, the center of the main shaft is located and another line drawn through this center at right angles to the vertical line. The location of the main shaft, a little above and to the left of the center, is shown in Fig. 4 by the largest hole in the plate. Each piece to be made is then drawn on a separate sheet of paper. All dimensions are given from the vertical or the horizontal line, or both.

This system of drawing makes it much easier for the drafstman to make an

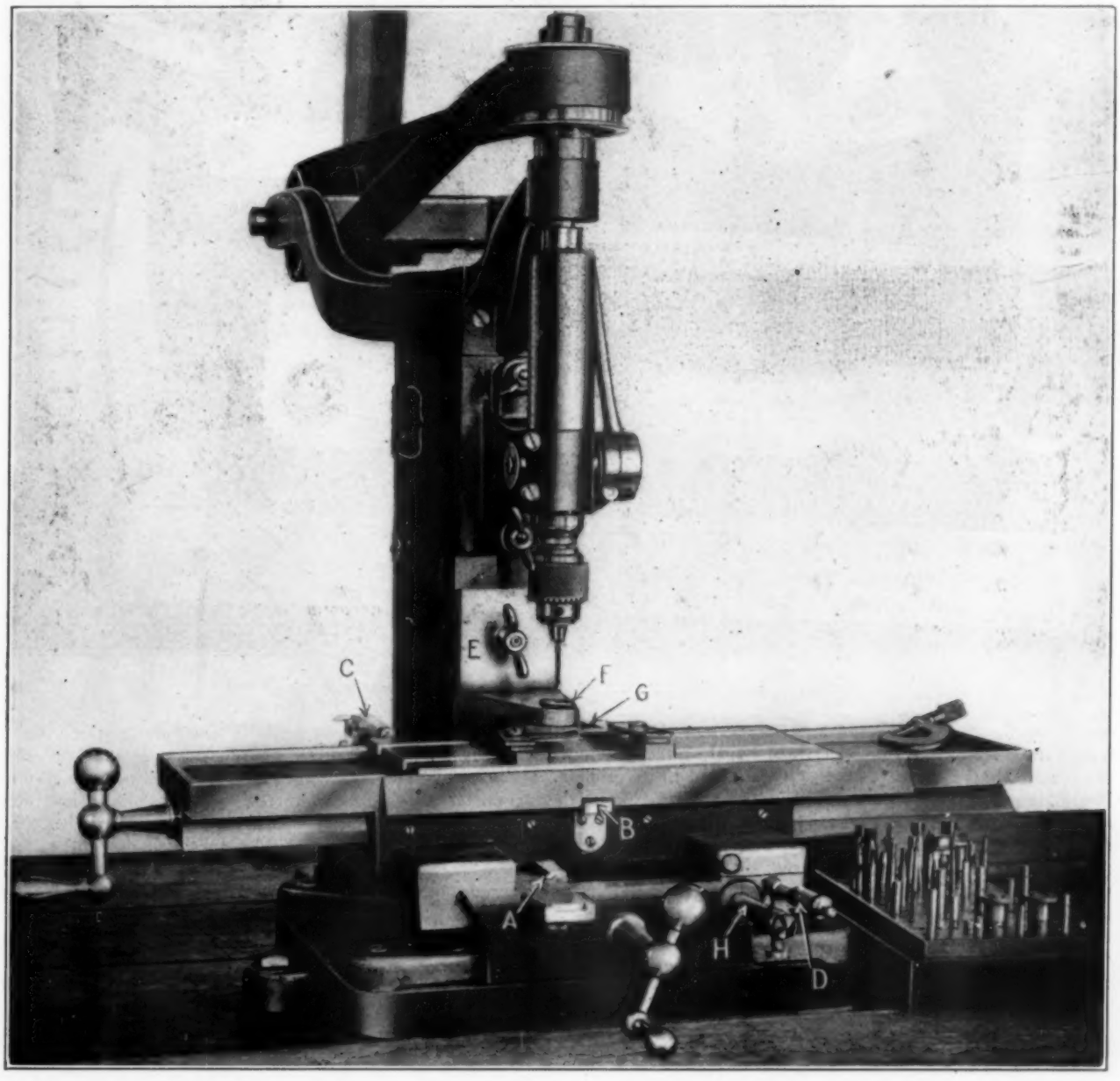


FIG. 1. DRILL PRESS FITTED FOR LAYING OUT WORK ACCURATELY

assembled drawing, as each piece is shown in the position it occupies in the machine. Each single-piece drawing can be laid on top of the assembled drawing and the part pricked through with a pin to see that it does not interfere with any other piece in the machine; or the piece on the single drawing can be transferred to the assembled drawing with less work than if drawn in any other position.

It also simplifies the work of the model-maker so that by moving the platen in, out or sideways to conform with the dimensions on the drawing, he can lay out and drill the piece on the specially rigged drill shown in Fig. 1.

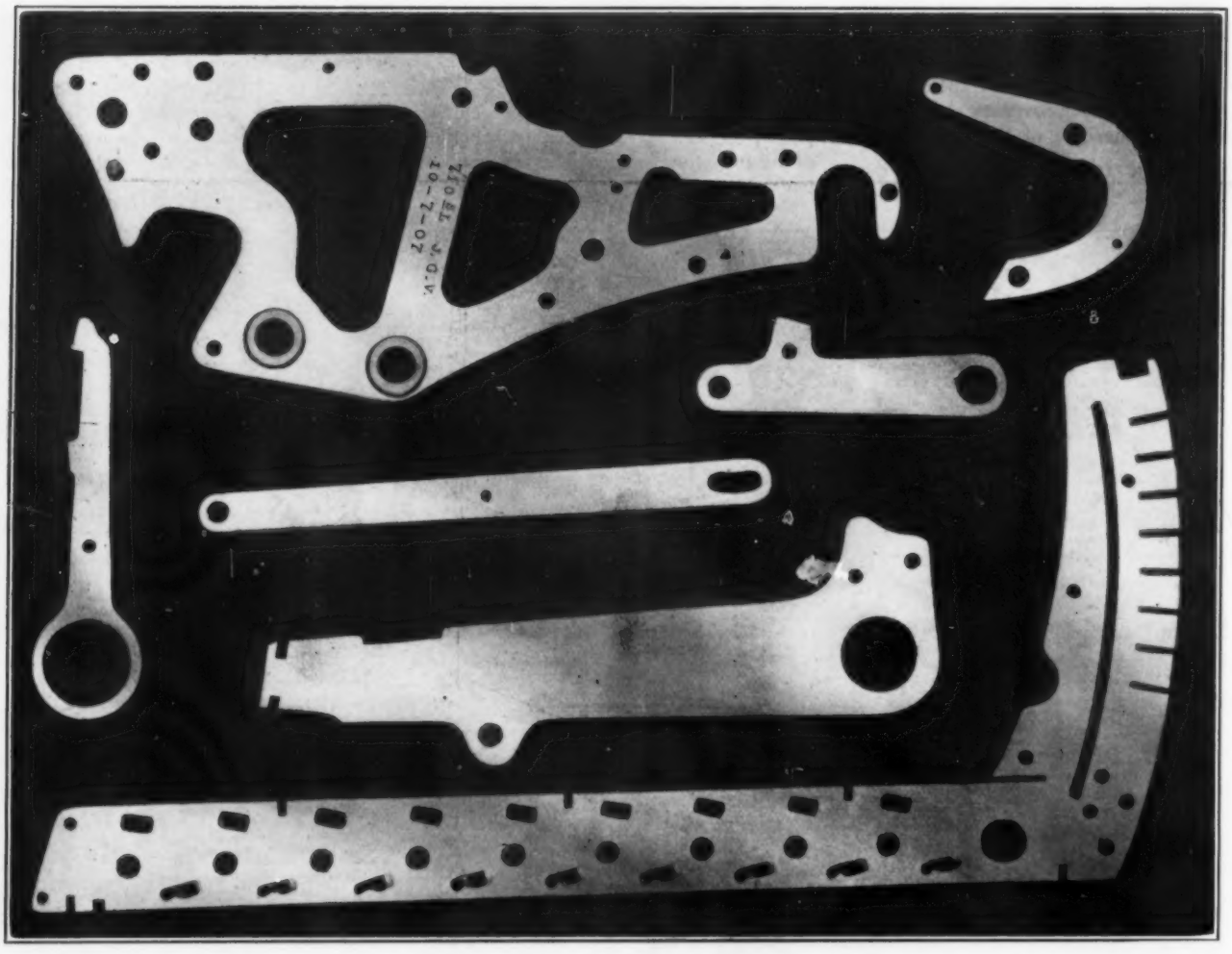


FIG. 2. A FEW OF THE PIECES LAID OUT ON THE DRILL PRESS

The adding machine is shown by Fig. 6 and a few of the parts in Fig. 2. It is composed of a large number of pieces, each working in unison with many others; hence each piece must be worked out to the exact sizes given on the drawings, as a variation of one-thousandth inch might throw some other part out so much that the machine would not work.

The Drill Press

In laying out and drilling this work, an ordinary vertical bench drill as made by the Sigourney Tool Company is fitted with two verniers, as shown at *A* and *B* in Fig. 1. One is used when the platen is moved in and out, and the other when it is moved to the right or left, so that adjustments can be made to the thousandth of an inch. At the back of the platen, as shown at *C*, is located a Boulet indicator. As this indicator has a scale laid out on an arc and graduated to thousandths of an inch, the platen can be moved out and returned to the exact position, after the work has been clamped to it. A pointer moving back and forth on the indicator gives the readings. This pointer in turn is moved by a push rod which presses against the platen when it has been returned to its original position.

At *D* is located a micrometer attachment with a stop by means of which the platen can be located, moved away for other operations and returned again to its original position. Where the distance between the centers of holes is but a few thousandths, by starting at the outside hole and drilling that first, the platen can be moved in by the micrometer and then moved to the right or left by the end screw, and the dimension located by the vernier at *B*. To give the micrometer a range of several inches, a shaft *H* is fastened to the bed of the drill press. The micrometer is moved in and out on this shaft and clamped to it by a thumb screw on the under side which presses a spit bushing against the shaft.

At *E* is located a knee containing a hole to receive the bushings *F*. The hole is trued up with great care and the bushings ground to an exact size and fit so that the drills, reamers or counterbores used in the machine, and shown in the case to the right of the drill press, will not be thrown out of true.

The work is clamped to the machine as shown by the piece at *G*. A piece of sheet metal is taken and a start made by drilling the most important hole first; then the platen is moved to make all other holes correspond to the dimensions given from this one. The method is best illustrated by the following description.

Working a Piece

To lay out and drill the piece shown by Fig. 3, a piece of sheet metal of the correct thickness and size is taken and a ½-inch hole drilled at *A*; this is then reamed out to 0.503 inch. The platen is moved to the left 6.174 inches, a ¼-inch hole drilled at *B* and reamed out to 0.252 inch. The platen is then moved in, or toward the back of the drill press, 0.486

inch and to the right 0.84 inch, which makes it 6.090 inches from the perpendicular line *C*. The hole *D* is drilled and reamed to 0.093 inch in diameter. The platen is then moved to the right 0.278 inch, making it 5.812 inches from line *C*, and out enough to make it 0.282 inch from the vertical center line, where a ⅛-inch hole is drilled at *E*. The same size hole is also drilled at *F* and *G* after moving the platen to correspond with the dimensions given in the drawing. The other holes in the piece are located, drilled and reamed in a like manner.

To get the opening at *I*, the platen is moved so that the centers from which the ¼-inch radii are struck will come under the center of the drill; then a ½-inch hole is drilled at each place and the balance of the stock worked out by other means. The large irregular-shaped hole in the center of the piece is worked out by using the same ½-inch drill to locate the three points marked ¼ inch *R*, and a ⅝ drill to locate the point marked 5/16 inch *R*. The other two irregular-shaped holes are worked out in the same manner; but as these are merely put there to lighten the piece, exactness is not required in locating the holes and no dimensions are given from the center lines.

The semicircular opening at *J* is obtained by moving the platen 3.319 inches less 5/64 inch to the left of the center of hole *A*, and 25/32 of an inch out from the same center. After drilling with a ¼-inch drill, the opening at *K* is located by moving the platen to the proper position and drilling a ⅝-inch hole.

Testing

After the holes are all drilled, each piece is tested by locating it on the plate shown in Fig. 4. This plate has been made out of a cast-iron block in which are drilled holes that are bushed with hardened-steel bushings so that there will be no wear to them after inserting the pins many times. The plate is also squared on the bottom so that it can be stood on edge on a surface plate. A vernier hight

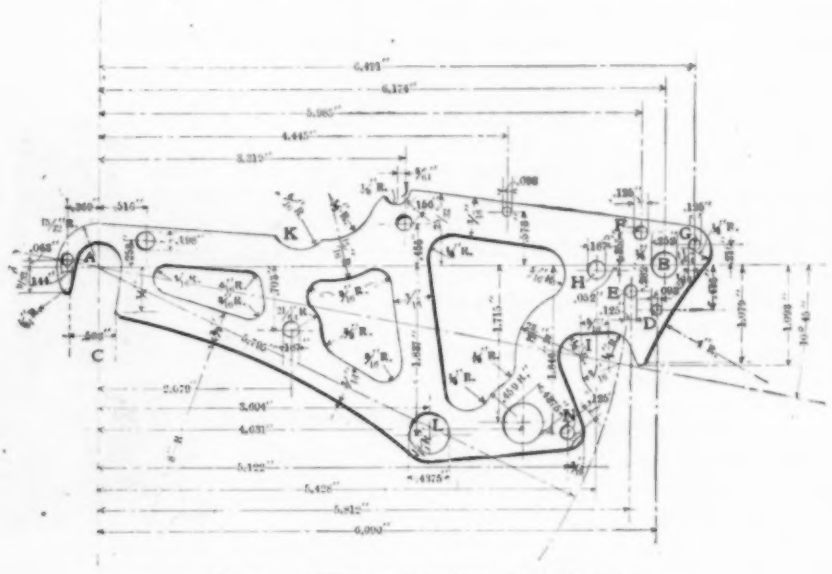


FIG. 3. A PIECE AS LAID OUT AND DRILLED

FIG. 4. THE PLATE ON WHICH ALL PIECES ARE TRIED TO DETERMINE THAT EACH HOLE IS AN EXACT FIT

gage, as shown at the right of the half-tone, is used to check all hight dimensions.

In this plate are located the important holes of each piece of the adding machine, from the cast-iron side frame shown lying down on the surface plate to the smallest sheet-metal lever, plate or bar. An idea of the number of the pieces which go into a complete machine can be obtained by a glance at Fig. 6, which will impress upon one the necessity of being exact with the dimensions of every piece.

The single-end plugs, which are a tight fit in the bushed holes in the plate, are shown in the case to the left of the plate. They are ground to an exact size so that no variation can occur in testing the pieces. A few double-ended plugs are used, similar to those shown on the face plate between the side frame and the plate.

The testing insures correctness in each piece before starting to assemble the machine and results in the assembling being done easily and quickly.

Finishing the Pieces

After drilling and testing the holes, the round corners scribed from the same center as a hole are obtained by inserting a plug with a head of the diameter that the round should be; on the other end of the plug is then placed a washer of the same diameter as the head. The plug and the washer have been ground and polished to the exact size of the radius given for the round corner and then case-hardened. After they are placed in position, the metal can be filed away until it is the same size as the head and washer of the plug. For instance, to get the round at the left-hand end of the piece shown in Fig. 3, a plug would be made 0.503 inch diameter in the body and 15/16 inch diameter on the head, with the washer the same diameter and a hole through it 0.503 inch in diameter. The plug is slipped through the hole *A*, the washer put on the end, the whole held in the vise and the end of the piece filed down to the head of the plug; as the plug is hardened, it will not allow any more filing, and the required radius of 15/32 inch is obtained.

This operation is repeated with different-sized plugs at *L*, *N* and *G*, giving the correct lines to work the rest of the shape of the piece to at these points.

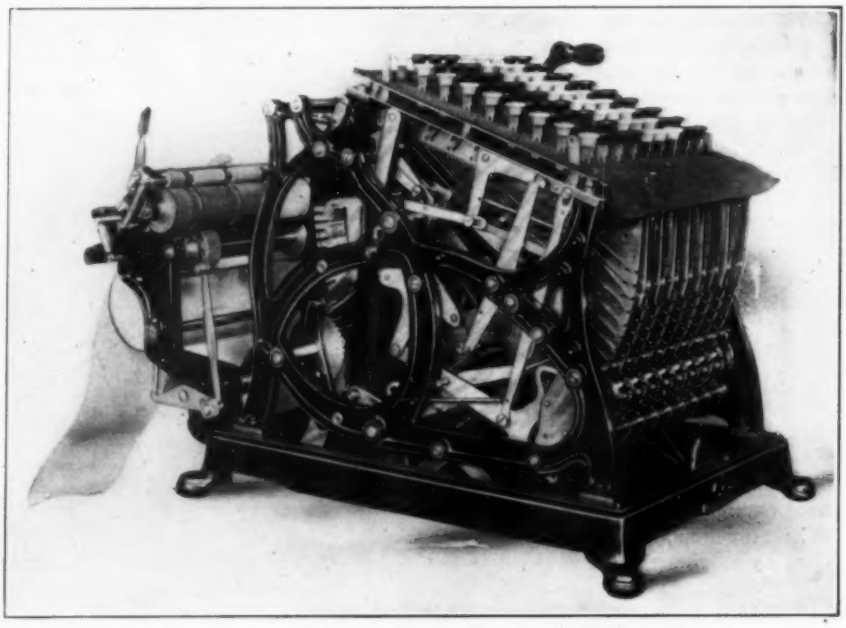


FIG. 6. ONE STYLE OF THE COMPLETED BURROUGHS ADDING MACHINE WITHOUT GLASS CASE

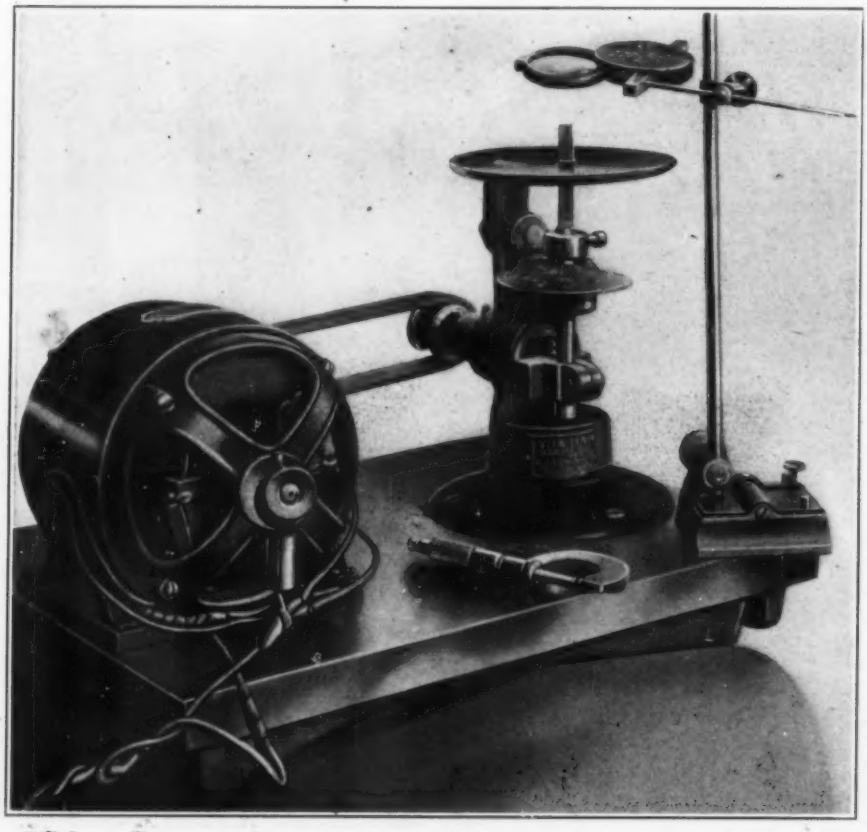


FIG. 5. PORTABLE FILING MACHINE AND MOTOR

The rest of the shape is worked out by the use of a filing machine, as shown in Fig. 5. An ordinary bench filing machine has been fastened to a face plate together with a small electric motor which can be connected to any electric-lamp socket. This makes a very handy rig, as it can easily be carried by the workman to any part of the shop in which he desires to do the work.

With the aid of a magnifying glass, as shown, and a little skill, the work can be brought to less than a thousandth of the size desired.

Importance of Close Work

This method of laying out and drilling work shows the care, skill and precision used by the Burroughs Adding Machine Company in building its first or experimental machine. The same careful workmanship is demanded when the tools, dies, jigs, etc., are made for manufacturing the machine in quantities, as the number of separate pieces in the smallest adding machines runs up into the hundreds. Each piece must be worked to the exact dimensions given, in order to work in conjunction or in unison with the numerous other parts it acts upon or comes in contact with.

In the completed machine as shown by Fig. 6, when a key is struck it not

only prints the figure required but operates other parts which record the figure in the machine. When a total is desired, the pulling of a lever on the right-hand side of the machine, or the touching of a key which sets in motion an electric motor that operates the lever, causes numerous other parts to come into operation and print the total of all the figures previously registered.

As will also be seen, this method of laying out will effect a great saving in time and enable the workman to work to the exact sizes in many other kinds of tool, experimental, or model work besides adding machines. With other attachments for raising and lowering the platen or head with precision to give exact depths, it might be used to good advantage in diemaking where certain depths are required. E. F. L.

A New British Gear-hobbing Machine

By I. W. Chubb

The firm of Humpage, Thompson & Hardy, Bristol, one of the latest in Great Britain to specialize on machine tools, and almost the only engineers in that line in the southwest of England, has sprung more or less directly from the firm which introduced the well-known Humpage epicyclic gear. The new firm has lately been confining itself entirely to a high-speed gear-hobbing machine for cutting spurs and worm wheels. These machines have been designed in seven sizes to cut gear wheels up to 52 inches diameter; but, whatever the size, the hight from floor level to the table top is constant. At present three machines are on the market, namely, the 16-inch, 22-inch and 32-inch sizes. The plant has been arranged almost solely for their manufacture. The machines generally follow accepted lines, two slides at right angles carrying saddles, one for the work and one for the hob. The slides are broad, flat and square. No V's are used; the first aim in the design has been stiffness. All parts are made to jigs and templets on the interchangeable system.

The machine consists of a number of self-contained devices. All gears are of steel, cut from the solid. The gears in the gear box and worm wheel for the work table run in oil baths; ring lubrication is provided for the main bearings, Stauffer lubricators elsewhere; all bushes are of bronze, and all bearings are at least 2½ diameters long; no stay for the work mandrel is used. The cast-iron worm wheel for the work table is in two horizontal halves; it is double threaded so as to reduce the speed at which the worm shaft runs, this feature being of importance when worm wheels with multiple threads such as are often used on motor cars, are being cut. The chief distinguishing features lie in the gear box, feed system and centering gage.

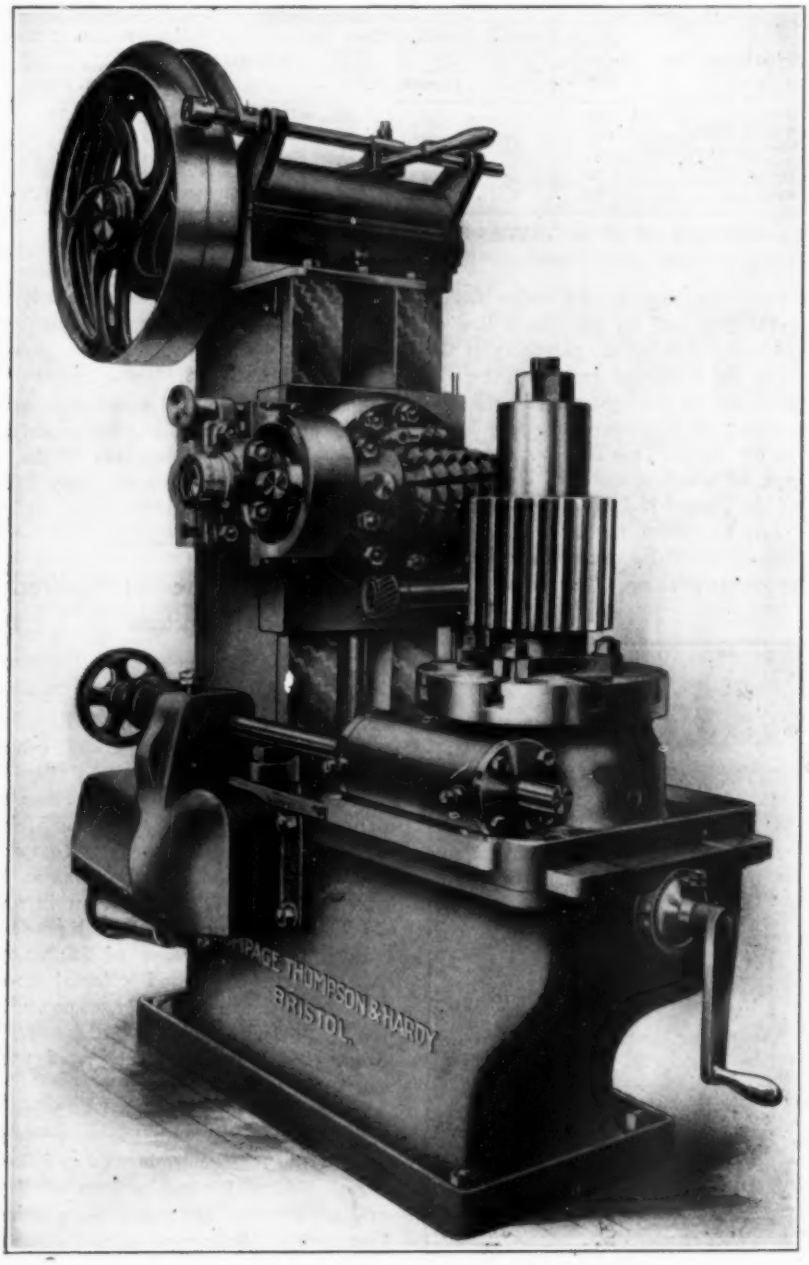


FIG. 1. A 16-INCH BRITISH GEAR-HOBBING MACHINE

The Hob Drive

In place of a step cone, the machine is driven from a constant-speed belt-driven shaft on the top, as shown in Fig. 1. This illustrates the smallest sized machine, which will cut up to No. 2 pitch in cast iron. It will be plain that an electric motor can be fitted without alteration to the gear box. This box provides four speeds. Four gear wheels with different numbers of teeth run loosely on the constant-speed shaft. Each gear wheel has four keyways. The shaft is hollow and for each gear wheel four slots are cut through from the outside to the bore and each slot is provided with a sliding key *A* (Fig. 2) the movement of which is at right angles to the axis. Inside of the shaft is a sliding spindle *B* which can be controlled from the outside. The keys rest on the arms of the spindle and are held down by lugs *C* shown in the cross-section. These slide in recesses milled along the arms. In places the arms are enlarged, as shown at *D*, and have inclined surfaces leading to and from these portions. When the enlarged parts are pushed beneath a set of keys, these are driven through the slots in the shaft and the corresponding gear is keyed to it. Meanwhile all the other sets of keys are locked down by the lugs engaging in the recesses, so that the three remaining gears run loose. Thus any one of the four gears can be keyed to the constant-speed shaft, according to the position of the sliding spindle. The four gears mesh with four similar gears keyed on a countershaft, from which motion is transmitted to the

vertical shaft in the pillar of the machine by means of bevel gears. The hobbing cutter is fed downward as usual, being carried by a saddle which is moved by means of a vertical screw. This, however, does not revolve when the automatic feed is on, being pulled by a revolving nut instead.

The Feed Mechanism

The work table is carried on another saddle and is moved as usual by a horizontal screw toward or from the hob to the required depth, according to the dimensions of the gear being cut. Automatic downward feed is provided for the hobbing cutter, or an inward feed for the work table for cutting worm wheels, with an automatic stop which can be set at any depth. The feed gear is driven by the worm shaft which revolves the work table. Two taper cone pulleys are used (see Fig. 3), one being driven from the worm shaft by spur gearing and transmitting its motion to the second cone by means of a belt which, by a screw-actuated fork, can be varied in position. To obtain a wide range of feeds the cones are used in conjunction with an epicyclic train, one member of which is driven by the constant-speed cone, while the other is driven by the variable-speed cone. Thus a slow motion is transmitted to the arm which carries the planet gears and, by altering the speed of the lower cone, the arm can be caused to revolve faster or slower, according to the required feed.

Bevel gears transmit the motion from the revolving arm to a spindle which carries at the other end a miter gear. This in turn can be made to engage with either of two miter gears, one driving the nut of the vertical screw and the other keyed to the horizontal screw. The cutter saddle is overbalanced by about 25 pounds to make sure of taking up all the backlash. The balancing weight is carried inside of the machine pillar.

Gage for Setting the Hob

The hob is set central by a small circular gage plate attached to a hinged rod. This rod is fastened on the cutter saddle above the hob and on the center line of the machine. Around the periphery of the plate are cut V-shaped grooves, these fitting the teeth of the hobs used in the machine. For each V-groove there is a dowel hole in the plate. This revolves on a central pin, on which it can also slide. The end of the hinged rod also bears a dowel. The plate is pulled forward on the pin and turned until the correct V-groove is in the lowest position. The plate is then pushed back and locked in position by the dowel. The hinged rod is then lowered toward the hob, which is moved longitudinally until the V-groove fits one of the teeth, touching both its sides. It will be noticed that, unlike other gages, this device allows the hob to be set while the blank is in position on the machine.

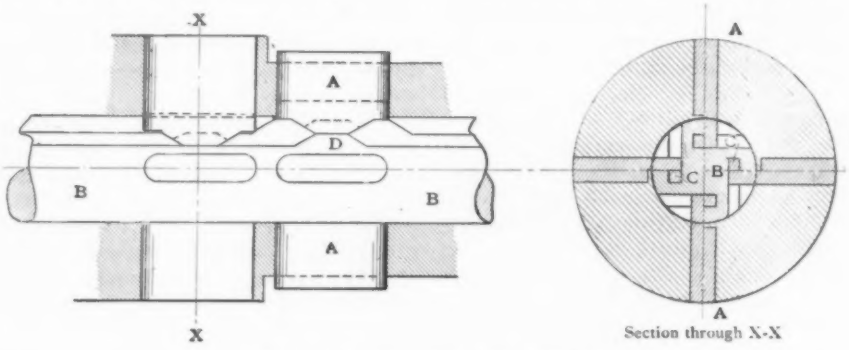


FIG. 2. SLIDING KEY AND SPINDLE

Material of the Gear.	No. of Teeth in Gear.	Diametral Pitch of the Gear.	Width of Face of Gear in Inches.	Time for Finishing in Minutes.	Material in Hob.	Pounds of Metal Removed per Minute, Cutting at Full Depth.
Cast iron	19	3	6¼	23	High Speed Steel.	0.75
Tough mild steel	21	3	2½	26	High Speed Steel.	0.39
Cast iron	15	2½	3	29	Carbon Steel.	0.49
Cast iron	11	2	3	28	Carbon Steel.	0.41
Mild steel	15	2½	3½	49	Carbon Steel.	0.32
Mild steel	12	2	3½	54	Carbon Steel.	0.36

RESULTS OF SOME TESTS OF A 32-INCH GEAR-HOBBING MACHINE.

Results of Some Hobbing Tests

Finally the results of some tests made by the firm appear in the accompanying table. The machine used was of the 32-inch size and driven by a three-ply balata belt, 2 inches wide.

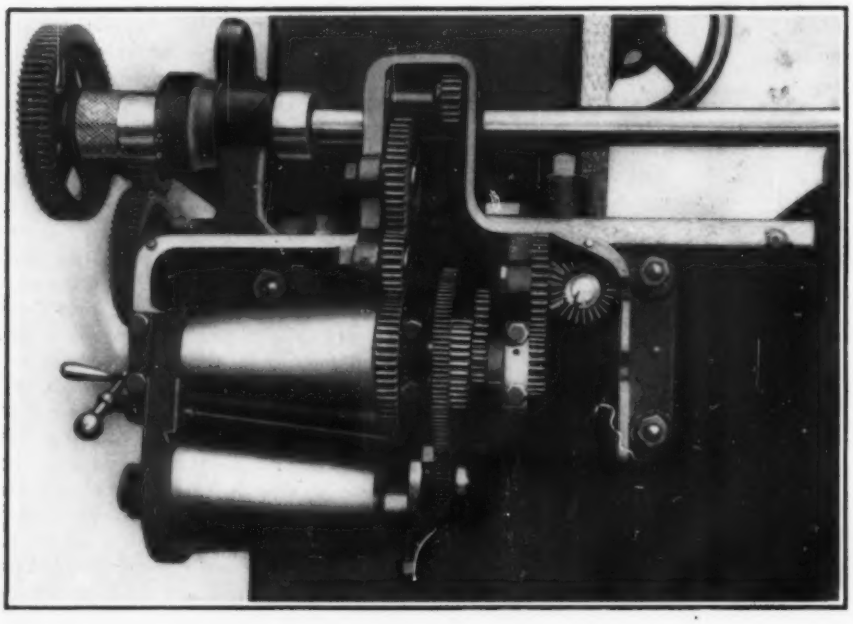


FIG. 3. THE FEEDING MECHANISM OF THE BRITISH GEAR HOBBER

Foreign Trade of United Kingdom

The following statistics, covering the foreign trade of the United Kingdom, have been furnished by Consul-general Robert J. Wynne, of London:

According to the Board of Trade returns, the foreign trade of the United Kingdom for October, 1907, as compared with the same month in 1906 was as follows: Imports, $280,612,637, an increase of $14,721,425; exports of British products, $186,481,944, an increase of $24,747,072; exports of foreign and colonial goods, $33,449,362, a decrease of $1,306,606. Bullion as specie: Imports, $26,452,892, an increase of $7,007,103; exports, $35,916,240, a decrease of $14,100,630.

For the ten months ended October 31, 1907, as compared with the same period of 1906, the foreign trade was as follows: Imports, $2,592,837,276, a gain of $171,098,543; exports, $1,740,263,729, a gain of $225,377,873. Bullion as specie: Imports, $252,040,906, a gain of $1,301,974; exports, $221,764,215, a decrease of $39,991,549.

Power Transmission by Friction Driving

Fiber and Metal Wheels Should Be Designed for Safe Pressures. Coefficients of Friction for Various Surfaces. Results of Tests*

BY W. F. M. GOSS†

A friction drive, as the term is here employed, consists of a fibrous or somewhat yielding driving wheel working in rolling contact with a metallic driven wheel. Such a drive may consist of a pair of plain cylindered wheels mounted upon parallel shafts, or a pair of beveled wheels, or of any other arrangement which will serve in the transmission of motion by rolling contact. The use of such drives has steadily increased in recent years, with the result that the so-called paper wheels have been improved in quality and a considerable number of new materials have been proposed for use in the construction of fibrous wheels.

The Wheels Tested

Choosing materials which have been used for such purposes, driving wheels of each of the following materials have been tested: straw fiber, straw fiber with belt dressing, leather fiber, leather, leather-faced iron, sulphite fiber, tarred fiber.

The straw-fiber wheels are worked out of blocks which are built up usually of square sheets of straw board laid one upon another with a suitable cementing material between them and compacted under heavy hydraulic pressure. In the finished wheel the sheets appear as disks, the edges of which form the face of the wheel. The material works well under a tool but it is harder and heavier than most woods and takes a good superficial polish. The wheel tested was taken from stock.

The wheel of straw fiber with belt dressing was similar to that of straw fiber, except that the individual sheets of straw board from which it was made had been treated, prior to their being converted into a block, with a "belt dressing," the composition of which is unknown to the writer.

The leather-fiber wheel was made up of cemented layers of board, as were those already described; but in this case the board, instead of being of straw fiber, was composed of ground sole-leather cuttings, imported flax and a small percentage of wood pulp. The material is very dense and heavy.

The leather wheel was composed of layers or disks of sole leather.

The leather-faced iron wheel consisted of an iron wheel having a leather strip cemented to its face. After less than 300 revolutions the bond holding the leather face failed and the leather separated itself from the metal of the wheel. This wheel proved entirely incapable of transmitting power and no tests of it are recorded.

The wheel of sulphite fiber was made up of sheets of board composed of wood pulp. The sulphite board is said to have been made on a steam-drying continuous-process machine in the same way as is the straw board.

	Coefficient of Friction when Contract Pressure is 150 Pounds per Inch.		
	Iron.	Aluminum.	Type Metal.
Sulphite fiber...	0.550	0.530	0.515
Leather fiber....	0.515	0.495	0.305
Straw fiber.....	0.425	0.455	0.310
Tarred fiber.....	0.250	0.305	0.275
Leather.....	0.225	0.360	0.410
Straw fiber with belt dressing..	0.120		

TABLE 1. COEFFICIENT OF FRICTION.

The tarred-fiber wheel was made up of board composed principally of tarred rope stock, imported French flax and a small percentage of ground sole-leather cuttings.

Each of the fibrous driving wheels was tested in combination with driven wheels of the following materials: Iron, aluminum, type metal. All wheels tested, both driving and driven, were 16 inches in diameter. The face of all driving wheels was 1¾ inches, while that of all driven wheels was ½ inch.

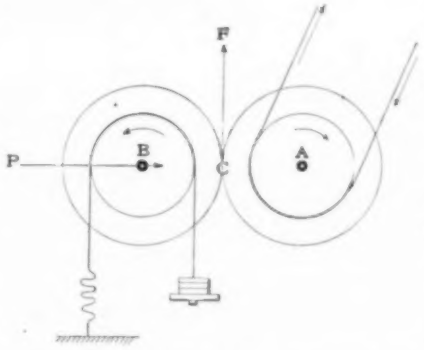


FIG. 1. DIAGRAM OF TESTING MACHINE FOR FRICTION WHEELS

The purpose of the experiments was to secure information which would permit rules to be formulated defining the power which may be transmitted by the various combinations of fibrous and metallic wheels already described. To accomplish this, it was necessary to determine for each combination of driving and driven wheel the coefficient of friction under various conditions of operation; also the maximum pressures of contact which can be withstood by each of the fibrous wheels.

The testing machine used is shown diagrammatically by Fig. 1. The principles involved will be made clear by assigning the functions of the actual machine to the several parts of this figure. The shaft A runs in fixed bearings and carries the fibrous friction wheel. This wheel is the driver. Its shaft A carries, besides the friction wheel, two belt pulleys, one on either side, belts to which, from any convenient source of power, serve to give motion to the driver. The shaft B carries the driven wheel, which in every case was of metal. The bearings of this shaft are capable of receiving motion in a horizontal direction and by means of suitable mechanism connected therewith, the metal driven wheel may be made to press against the fibrous driver with any force desired. The pressure transmitted from B to A is hereinafter referred to as the "pressure of contact" and is frequently represented by the symbol P. The tangential forces which are transmitted from the driver to the driven wheel are received, absorbed and measured by a friction brake upon the shaft B. In action, therefore, the driven wheel always works against a resistance, which resistance may be modified to any desired degree by varying the load upon the brake. The theory of the machine assumes that the energy absorbed by the brake equals that transmitted from the driver to the driven wheel at the contact point C. Accepting this assumption, the forces developed at the periphery of the brake wheel may readily be reduced to equivalent forces acting at the circumference of the driven wheel. This force, which is directly transmitted from the driver to the driven wheel, is hereinafter designated by the symbol F. It will be apparent from this description that the functions of the apparatus employed are such as will permit a study of the relationship existing between the contact pressure P and the resulting transmitted force F, which relation is most conveniently expressed as the coefficient of friction. It is,

$$f = \frac{F}{P}.$$

It is obvious in comparing the work of two friction wheels that the one which develops the highest coefficient of friction, other things being equal, can be de-

*Abstract of paper presented to the American Society of Mechanical Engineers, December, 1907.

†Professor, University of Illinois.

pended upon to transmit the greatest amount of power.

The actual machine as used in the experiments is shown by Fig. 2. Its construction satisfies all conditions which have been defined except that shaft *B*, Fig. 1, does not run in bearings which are absolutely frictionless, as is required by a rigid adherence to the theoretical analysis already given. These bearings, however, are of the "standard roller bearing" type and of ample size, and it is believed that the friction actually developed by them is so small compared with the energy transmitted between the wheels that it may be neglected.

The bearings of the fixed shaft *A* are secured to the frame of the machine. The bearings of the axle *B* are free to move horizontally in guides to which they are well fitted. These bearings are connected by links to the short arm of a bell-crank lever, the longer arm of which projects beyond the frame of the machine at the right-hand end and carries the scale pan and weights *E*. The effect of the weights is to bring the driven wheel in contact with the driver under a predetermined pressure, the proportions of the bell-crank lever being such as to make this pressure in pounds equal,

$$P = 10\ W + 73$$

where W is the weight on the scale pan *E*.

The fulcrum of the bell-crank lever is supported by a block *G* which may be adjusted horizontally by the hand wheel *H* at the rear of the machine, so that whatever may be the diameter of the driven wheel, the long arm of the bell crank may be brought to a horizontal position. The constants employed in calculating the coefficient of friction from observed data are as follows:

Diameter of friction wheels (inches)	16
Effective diameter of brake (inches)	18.35
Ratio of diameter of friction wheel to that of brake wheel	1.145
Effective load on brake	F
Coefficient of friction	$1.147 \frac{F}{P}$

The slippage between the friction wheels was determined from readings taken from the counters connected to each one of the shafts.

The Tests

In proceeding with a test, load was applied to the scale pan *E*, Fig. 2, to give the desired pressure of contact, after which the hand wheel *H* at the back of the machine was employed to bring the bell crank to its normal position. This accomplished, with the driving wheel in motion, the driven wheel would roll with it under the desired pressure of contact. A light load was next placed upon the brake to introduce some resistance to the motion of the driven shaft, and conditions thus obtained were continued constant for a considerable period. Readings were taken simultaneously from the counters and time noted. After a considerable interval the counters were again read, time again noted, and the test assumed to have ended. From the readings of the counters and from the known diameters of the wheels in contact, the per cent. of slip attending the action of the friction wheels was calculated. Three facts were thus made of record, namely: (*a*) The pressure of contact; (*b*) the coefficient of friction developed, and (*c*) the per cent. of slip resulting from the development of said coefficient of friction.

This record having been completed, the load upon the brake was increased and observations repeated, giving for the same pressure of contact a new coefficient of friction and a higher percentage of slip. This process was continued until the slippage became excessive and in consequence thereof the rotation of the driver ceased. By this process a series of tests was developed disclosing the relation between slip and coefficient of friction for the pressure in question. Such a series having been completed, the load upon the weight holder *E* was changed, giving a new pressure of contact, and the whole process repeated. As the work proceeded, curves showing the relation of coefficient of friction and slip for pressures per inch width of face in contact of 150 pounds and 400 pounds, respectively, were secured. The curves shown by Figs. 3 and 4 for the straw-fiber driving wheel in contact with the iron driven wheel are typical in their general form of those obtained from all combinations of wheels, but the curves of no two combinations were alike in their numerical values.

Having completed this series of tests at constant pressure, a series was next run for which the coefficient of slip was maintained constant at 2 per cent. and the pressure of contact varied from values which were low to those which are judged to be near the maximum for service conditions, with results which in all cases were similar in character with those given for the straw-fiber and iron wheels, as set forth by Fig. 5. The numerical values of the points for other combinations were not the same as those shown by Fig. 5, but in the case of most of the combinations the coefficient of friction at constant slip gradually diminishes as the pressure of contact is increased.

As the series of tests involving each combination of wheels proceeded, the increase in pressure of contact was discontinued when the markings made upon the driving wheel by the metallic follower became so distinct as to suggest that a safe limit had been reached, but when all other data had been secured, tests were run for the purpose of determining the ultimate resistance of the fibrous wheel to crushing. The details of these will be described later.

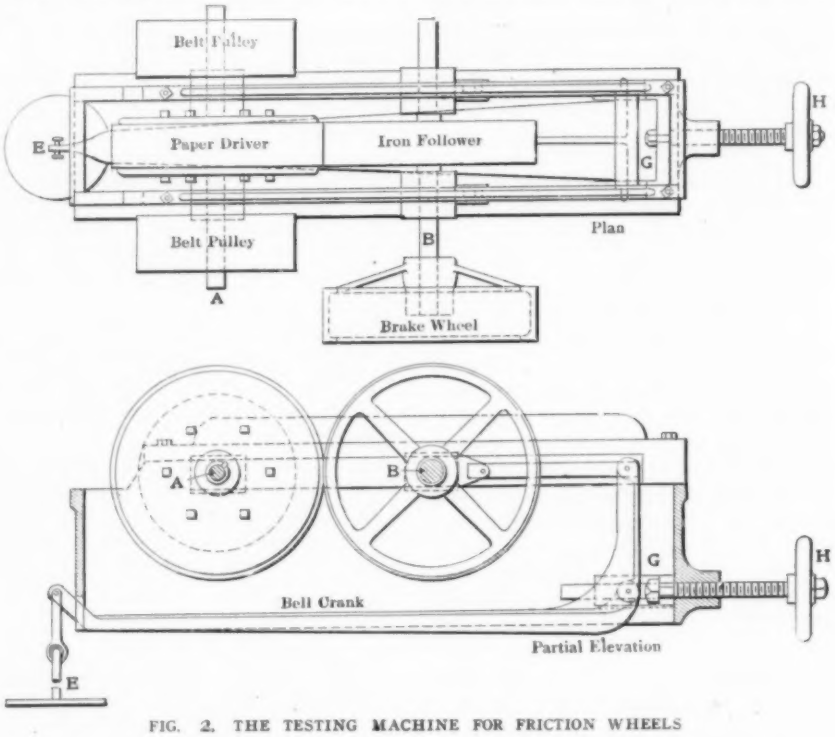


FIG. 2. THE TESTING MACHINE FOR FRICTION WHEELS

Coefficient of Friction Developed by the Several Combinations of Wheels — Straw Fiber and Iron

The results of experiments involving a straw-fiber driver and an iron driven wheel are shown graphically in Figs. 3, 4 and 5. Figs. 3 and 4 illustrate the relation between slip and coefficient of friction when the two wheels are working together under preessures per inch width of 150 and 400 pounds, respectively.

The figures show that although the values of the coefficient of friction for 400 pounds pressure are slightly lower than corresponding ones for 150 pounds pres-

sure, the curves are sufficiently similar to establish the fact that the law governing change in coefficient of friction with slip is independent of the pressure of contact. When the slippage is 2 per cent. the coefficient of friction is 0.425 for a contact pressure of 150 pounds, and 0.410 for a contact pressure of 400 pounds. That the coefficients of friction for all pressures between the limits of 150 pounds and 400 pounds are practically constant is well shown by the diagram, Fig. 5. The pressure of 400 pounds is the maximum at which tests of this combination of wheels were run, though straw fiber was successfully worked up to a pressure of 750 pounds.

Straw Fiber and Aluminum

By curves plotted from values for a straw-fiber driver and an aluminum driven wheel, it can be shown that when the working pressure is 150 pounds per inch width and the slippage is 2 per cent., the coefficient of friction is 0.455; also, that for all pressures ranging from 100 to 400 pounds, the coefficient of friction is practically constant when the rate of slip is constant. The maximum pressure at which tests involving this combination of wheels were run was 400 pounds per inch width.

Straw Fiber and Type Metal

By curves plotted from values for a straw-fiber driver and a type-metal driven wheel it can be shown that when the two wheels are operated under a pressure of contact of 150 pounds per inch width and when the slip is 2 per cent., the coefficient of friction is 0.310; also, that for all pressures of contact ranging from 100 to 400 pounds, the coefficient of friction is practically constant when the slip is constant.

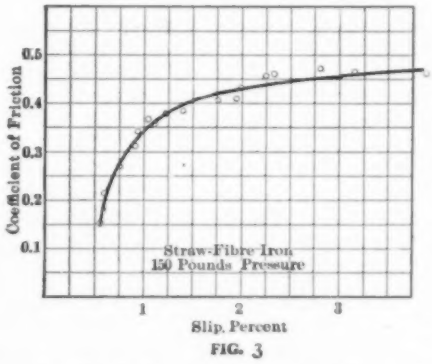


FIG. 3

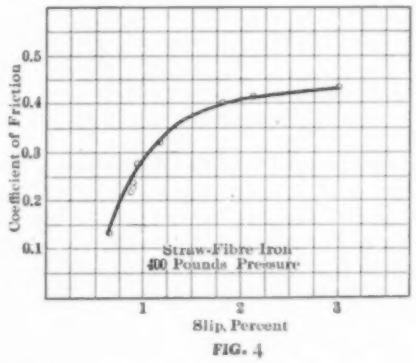


FIG. 4

CURVES FOR STRAW FIBER AND IRON, TYPICAL FOR ALL CURVES PLOTTED FROM THE FRICTION TESTS

Straw Fiber with Belt Dressing and Iron

Curves plotted from values for a straw-fiber driver treated with belt dressing, and an iron driven wheel show that when the two wheels are worked together under a pressure of 150 pounds per inch width and when the slip is 2 per cent., the coefficient of friction is 0.12; also, that for all pressures up to 400 pounds per inch width, the coefficient of friction remains constant. The greatest preessure at which tests of this combination of wheels were run was 500 pounds per inch width.

Leather Fiber and Iron

Curves plotted from the results of tests involving a leather-fiber driver and an iron driven wheel show that when the two wheels are worked together under pressure of 150 pounds per inch in width and when the slip is 2 per cent., the coefficient of friction is 0.515. When the contact pressure is 300 pounds per inch width, the coefficient of friction is 0.510. The greatest pressure at which tests of this combination of wheels were run was 350 pounds per inch width, although leather fiber was successfully worked up to a pressure of 1200 pounds per inch width.

Leather Fiber and Aluminum

Curves plotted from the results of experiments involving a leather-fiber driver and an aluminum driven wheel show that under a contact pressure of 150 pounds per inch width and a slip of 2 per cent., the coefficient of friction is 0.495. This value remains practically constant under all pressures. The maximum pressure used in tests of this combination of wheels was 400 pounds.

Leather Fiber and Type Metal

Curves plotted from the results of experiments involving a leather-fiber driver and a type-metal driven wheel show that when the wheels are operated under a contact pressure of 150 pounds per inch width and when the slip is 2 per cent., the coefficient of friction is practically independent of the pressure of contact. When the slip is 2 per cent., the coefficient of friction is 0.220 for a pressure of contact of 150 pounds, and 0.250 for a pressure of contact of 400 pounds per inch width.

Tests of this combination were made also under different speeds when the wheels were working together under a pressure of contact of 250 pounds per inch width and when the slip was 2 per cent., with the result that the coefficient of friction was found to remain nearly constant for speeds of 450 and 3350 feet per minute, respectively. The greatest pressure at which tests of this combination of wheels were run was 400 pounds per inch width, although tarred fiber was successfully worked up to a pressure of 1200 pounds per inch width.

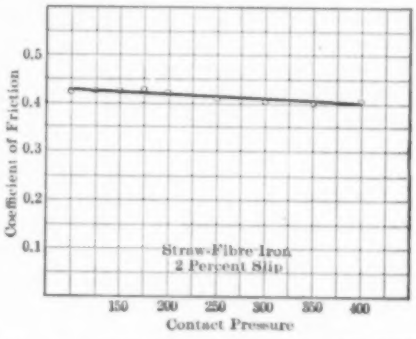


FIG. 5. CURVE FOR STRAW FIBER AND IRON WITH A CONSTANT SLIP

Tarred Fiber and Aluminum

Curves plotted from the results of experiments involving a tarred-fiber driver and an aluminum driven wheel show that when the slip is 2 per cent. and the pressure of contact 150 pounds per inch width, the coefficient of friction is 0.305; also, that for a pressure of 400 pounds per inch width, the coefficient of friction is 0.295. The greatest pressure at which tests of this combination were run was 400 pounds per inch width.

Tarred Fiber and Type Metal

Curves plotted from the results of experiments involving a tarred-fiber driver and a type-metal driven wheel show that when the slip is 2 per cent., the coefficient of friction developed under 150 pounds pressure per inch width is 0.275; and under 400 pounds pressure per inch width, the coefficient of friction is 0.270. The maximum pressure at which tests of this combination of wheels were run was 400 pounds per inch width.

Tarred Fiber and Iron

Curves plotted from the results of the experiments involving a tarred-fiber driver and an iron driven wheel show that the change in the value of the coefficient

Leather and Iron

Curves plotted from the results of experiments involving a leather driver and an iron driven wheel show that when the slip is 2 per cent. the coefficient of friction under a pressure of contact of 15 pounds per inch in width is 0.225 and under a pressure of 400 pounds, 0.215.

The maximum pressure at which tests of this combination of wheels were run was 400 pounds per inch width, although the leather driver was successfully operated up to a pressure of 750 pounds per inch width.

Leather and Aluminum

Curves plotted from the results of experiments involving a leather driver and an aluminum driven wheel show that when the pressure is 150 pounds per inch in width and the slip is 2 per cent., the coefficient of friction is 0.260; and when the pressure is 300 pounds per inch in width, the coefficient of friction is 0.295. The maximum pressure at which tests of this combination of wheels were made was 350 pounds per inch width.

Leather and Type Metal

Curves plotted from the results of the experiments involving a leather driver and a type-metal driven wheel show that when the slip is 2 per cent. and the contact pressure 150 pounds per inch width, the coefficient of friction developed is 0.410. The greatest pressure at which tests of this combination of wheels were run was 350 pounds per inch width.

Sulphite Fiber and Iron

Curves plotted from the results of the experiments involving a sulphite-fiber driver and an iron driven wheel show that when the slip is 2 per cent. and the pressure 150 pounds per inch width, the coefficient of friction is 0.550. The maximum pressure at which tests of this combination of wheels were run was 350 pounds per inch width, although the sulphite-fiber wheel was successfully operated up to a pressure of 700 pounds per inch width.

Sulphite Fiber and Aluminum

Curves plotted from the results of the experiments involving a sulphite-fiber driver and an aluminum wheel show that when the slip is 2 per cent. and the pressure 150 pounds per inch width, the coefficient of friction developed is 0.410. The greatest pressure used in tests of this combination of wheels was 350 pounds per inch width.

Sulphite Fiber and Type Metal

Curves plotted from the results of the experiments involving a sulphite-fiber driver and a type-metal driven wheel show that when the slip is 2 per cent. and the contact pressure 150 pounds per inch width, the coefficient of friction is 0.515. The maximum pressure used in tests of this combination of wheels was 350 pounds per inch width.

Resistance to Crushing

Upon the completion of tests designed to disclose the frictional qualities of the several combinations, each fibrous wheel was subjected to test for the purpose of determining the maximum pressure per inch width of the face which could be sustained by it. This was accomplished by placing the wheel to be tested in the machine, under a pressure of contact of 200 pounds per inch width. The load on the brake was then adjusted to give a 2 per cent. slip, and this brake load was maintained without change throughout the remainder of the tests. Thus adjusted, the machine was operated until the driver had completed 15,000 revolutions. This accomplished, and for the purpose of determining the reduction, if any, in the diameter of the fibrous wheel, the brake load was removed and the operation of the machine continued without load for a period of 6000 revolutions, the readings of the counters being taken at the beginning and at the end of the period. Under conditions of no load, the actual slip was assumed to be zero and the apparent slip observed was used for determining the reduction in diameter of the fibrous wheel which had been brought about by the previous running under pressure. This accomplished, the pressure of contact was increased, usually by 100-pound increments, and the whole operation repeated. This process was continued until failure of the fibrous wheel resulted. It will be seen that the ultimate failure of the fibrous wheel resulted. It will be seen that the ultimate resistance to crushing, as found by the process described, is that pressure which could not be endured during 15,000 revolutions.

A summary of results is as follows:

	Load in Pounds.	Decrease in Diameter.	
Straw fiber.	200	0.000	Wheel failed before running 15,000 revolutions under 750 pounds pressure.
	650	0.053	
	750	0.125	
Leather fiber.	200	0.000	Wheel failed before running 15,000 revolutions under 1200 pounds pressure.
	300	0.005	
	400	0.013	
	500	0.021	
	600	0.027	
	700	0.040	
	800	0.051	
	900	0.068	
	1000	0.099	
	1100	0.125	
	1200	0.200	
Tarred fiber.	200	0.000	Wheel failed before running 15,000 revolutions under 1200 pounds pressure.
	300	0.026	
	400	0.038	
	500	0.052	
	600	0.071	
	700	0.098	
	800	0.138	
	900	0.182	
	1000	0.250	
	1100	0.295	
	1200		
Leather.	350	0.047	Wheel failed before running 15,000 revolutions under 750 pounds pressure.
	450	0.090	
	550	0.150	
	650	0.240	
	750		
Sulphite fiber.	200	0.010	Wheel failed before running 15,000 revolutions under 700 pounds pressure.
	300	0.032	
	400	0.056	
	500	0.088	
	600	0.146	
	700	0.258	

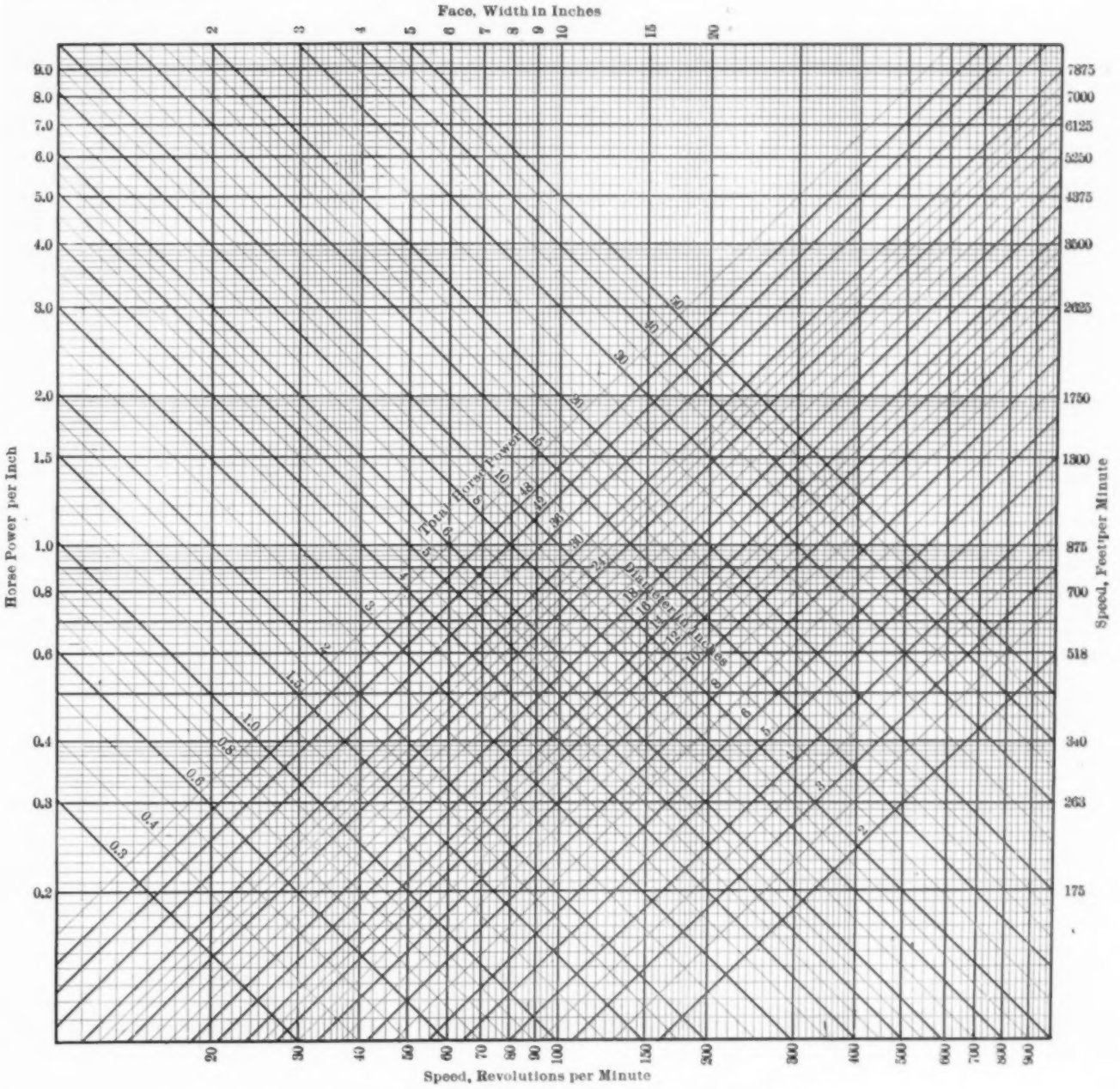
TABLE 2. STRENGTH OF VARIOUS FIBER WHEELS

A Conclusion as to Metal Wheels

An examination of Table 1, which presents a comparison of values representing the coefficient of friction of the several combinations of wheels tested, reveals the fact that the relative value of the metal driven wheels is not the same when operated in combination with different fibrous driving wheels. It appears that those driving wheels whjch are the more dense work more efficiently with the iron follower than with either the aluminum or type-metal followers; but in the case of the softer and less dense driving wheels, and especially in the case of those in which an oily substance is incorporated, driven wheels of aluminum and type metal are superior to those of iron. Finely powdered metal which is given off from the surface of the softer metal wheels seems to account for this effect, and the character of the driving wheels is perhaps the only factor necessary to determine whether its presence will be beneficial or detrimental. Finally, with reference to the use of soft-metal driven wheels, it should be noted that no combination of such wheels with a fibrous driver appears to have given high frictional results. Except when used under very light pressures, the wear of the type metal was too rapid to make a wheel of its material serviceable in practice.

Conclusions as to Fibrous Wheels

The relative value of the different fibrous wheels when employed as drivers in a friction drive may be judged by comparing their frictional qualities as set forth in Table 1 and their strength as set forth in Table 2. The results show at once that the addition of belt dressing to the composition of a straw-fiber wheel is fatal to its frictional qualities. The highest frictional qualities are



Proportions of Fibrous Friction Gearing

Explanatory:

The chart is plotted for the most common materials used for friction gearing, straw-fiber and cast iron, and gives means of determining the variable factors for the fiber wheel in the formula *horse-power* = 0.0003 *d W N*, in which *d* is the diameter of the wheel in inches, *W* its width of face in inches and *N* the number of revolutions per minute.

To use the chart for other friction materials multiply the values obtained from the chart by the proper factor selected from the table below:

Straw-fiber and aluminum....	1.10
Straw-fiber and type metal...	0.73
Leather-fiber and cast iron....	1.97
Leather-fiber and aluminum...	1.90
Leather-fiber and type metal..	1.17
Tarred-fiber and cast iron....	0.97
Tarred-fiber and aluminum...	1.17
Tarred-fiber and type metal...	1.03
Sulphite-fiber and cast iron...	1.23
Sulphite-fiber and aluminum..	1.17
Sulphite-fiber and type metal	1.13
Leather and cast iron.....	0.53
Leather and aluminum.....	0.87
Leather and type metal.....	0.97

a. To find the total horse-power which can be transmitted by a wheel, having given the diameter of the wheels in inches, the width of its face in inches and the revolutions per minute, locate the intersection of the vertical line representing the given speed with the diagonal line representing the given diameter. Follow the horizontal line passing through this point, to the right or left as the case may be, until it intersects the vertical line representing the given width of face. The diagonal line through this point will give the total horse-power required from the scale so marked.

b. To find the speed in revolutions per minute for a wheel, having given its diameter in inches, its width of face in inches, and the total horse-power to be transmitted, locate the intersection of the vertical line representing the width of face with the diagonal line representing the total horse-power to be transmitted. Follow the horizontal line passing through this point, to the right or left as the case may be, until it intersects the diagonal line representing the diameter in inches. The vertical line passing through this point indicates on the scale at the bottom of the chart the speed required.

c. To find the width of face in inches for a wheel, having given the total horse-power to be transmitted, its diameter in inches and its speed in revolutions per minute, locate the intersection of the vertical line representing the given speed with the diagonal line representing the given diameter. Follow the horizontal line passing through this point, to the right or left as the case may be, until it intersects the diagonal line representing the given total horse-power. The vertical line passing through this point will indicate the width of face required on the scale at the top of the chart.

d. To find the diameter in inches for a wheel, having given the horse-power to be transmitted, its width of face in inches, and its speed in revolutions per minute, locate the intersection of the vertical line representing the width of face with the diagonal line indicating the total horse-power. Follow the horizontal line passing through this point, to the right or left as the case may be, until it intersects the vertical line representing the speed. The diagonal line passing through this point represents the diameter which is required.

e. To find the surface speed of a wheel, having given its diameter in inches, and its speed in revolutions per minute, locate the intersection of the vertical line representing the speed in revolutions per minute with the diagonal line representing the given diameter. The horizontal line passing through this point represents the surface speed in feet per minute which is required, and which is read on the vertical scale at the right of the chart.

f. To find the horse-power per inch of face for a wheel, having given the total horse-power transmitted and the width of the face in inches, locate the intersection of the vertical line representing the width of face, with the diagonal line representing the total horse-power. The horizontal line passing through this point represents the horse-power per inch of face required and may be read on the vertical scale at the left of the chart.

possessed by the sulphite-fiber wheel which, on the other hand, is the weakest of all wheels tested. The leather fiber and tarred fiber are exceptionally strong; and the former possesses frictional qualities of a superior order. The plain straw fiber, which in a commercial sense is the most available of all materials dealt with, when worked upon an iron follower possesses frictional qualities which are far superior to leather, and strength which is second only to the leather fiber and the tarred fiber.

The Power Capacity of Friction Gears Concerning the Application of Results

A review of the data discloses the fact that several of the friction wheels tested developed a coefficient of friction which in some cases exceeded 0.5. That is, such wheels rolling in contact have transmitted from driver to driven wheels a tangential force equal to 50 per cent. of the force maintaining their contact. These wheels, also, were successfully worked under pressures of contact approaching 500 pounds per inch in width. Employing these facts as a basis from which to calculate power, it can readily be shown that a friction wheel a foot in diameter, if run at 1000 revolutions per minute, can be made to deliver in excess of 25 horsepower for each inch in width. It is certainly true that any of the wheels tested may be employed to transmit for a limited time an amount of power which, when gaged by ordinary measures, seems to be enormously high; but obviously, performance under limiting conditions should not be made the basis from which to determine the commercial capacity of such devices. In view of this fact, it is important that there be drawn from the data such general conclusions with reference to pressures of contact and frictional qualities as will constitute a safe guide to practice.

Working Pressure of Contact

The results of these experiments do not furnish an absolute measure of the most satisfactory pressure of contact for service conditions. Other things being equal, the power transmitted will be proportional to this pressure and hence it is desirable that the value be made as high as practicable. On the other hand, it has been noted as one of the observations of the test that as higher pressures are used, there appears to be a gradual yielding of the structure of the fibrous wheels; and it is reasonable to conclude that the life of a given wheel will in a large measure depend upon the pressure under which it is required to work. After a careful study of the facts involved, it has been determined to base an estimate of the power which may be transmitted upon a pressure of contact which is 20 per cent. of the ultimate resistance of the material as established by the crushing tests already described. This basis gives the following results:

SAFE WORKING PRESSURES OF CONTACT

	Pressure.
Straw fiber	150
Leather fiber	240
Tarred fiber	240
Sulphite fiber	140
Leather	150

Coefficient of Friction

The coefficient of friction for all wheels tested approaches its maximum value when the slip between driver and driven wheel amounts to 2 per cent. and, within narrow limits, its value is practically independent of the pressure of contact. A summary of maximum results is shown by Table 1. In view of these facts, it is proposed to base a measure of the power which may be transmitted by such friction wheels as those tested upon the frictional qualities developed at a pressure of 150 pounds per inch of width, when operating under a load causing 2 per cent. slip. For safe operation, however, deductions must be made from the observed values. Thus, the results of the experiments disclose the power transmitted from wheel to wheel, while in the ordinary application of friction drives some power will be absorbed by the journals of the driven axle so that the amount of power which can be taken from the driven shaft will be somewhat less than that transmitted to the wheel on said shaft. Again, under the conditions of the laboratory, every precaution was taken to keep the surfaces in contact free of all foreign matter. It was, for example, observed that the accumulation of laboratory dust upon the surfaces of the wheels had a temporary effect upon the frictional qualities of the wheels, and friction wheels in service are not likely to be as carefully protected as were those in the laboratory. In view of these facts, it has been thought proper to use as the basis from which to determine the amount of power which may be transmitted by such wheels as those tested, a coefficient of friction which shall be 60 per cent. of that developed under the conditions of the laboratory. This basis gives the following results:

COEFFICIENT OF FRICTION—WORKING VALUES.

	Coefficient of friction.
Straw fiber and iron	0.255
Straw fiber and aluminum	0.273
Straw fiber and type metal	0.186
Leather fiber and iron	0.309
Leather fiber and aluminum	0.297
Leather fiber and type metal	0.183
Tarred fiber and iron	0.150
Tarred fiber and aluminum	0.183
Tarred fiber and type metal	0.165
Sulphite fiber and iron	0.330
Sulphite fiber and aluminum	0.318
Sulphite fiber and type metal	0.309
Leather and iron	0.135
Leather and aluminum	0.216
Leather and type metal	0.246

Horse-power

Having now determined a safe working pressure of contact and a representative value for the coefficient of friction, it is possible to formulate equations expressing the horse-power which may be transmitted by each combination of wheels tested. Thus, calling d the diameter of the friction wheel in inches, W the width of its face in inches and N the number of revolutions per minute, the equations become, for combinations of,

	Horse-power
Straw fiber and iron	0.00030 dWN
Straw fiber and aluminum	0.00033 dWN
Straw fiber and type metal	0.00022 dWN
Leather fiber and iron	0.00059 dWN
Leather fiber and aluminum	0.00057 dWN
Leather fiber and type metal	0.00035 dWN
Tarred fiber and iron	0.00029 dWN
Tarred fiber and aluminum	0.00035 dWN
Tarred fiber and type metal	0.00031 dWN
Sulphite fiber and iron	0.00037 dWN
Sulphite fiber and aluminum	0.00035 dWN
Sulphite fiber and type metal	0.00034 dWN
Leather and iron	0.00016 dWN
Leather and aluminum	0.00026 dWN
Leather and type metal	0.00029 dWN

The accompanying chart gives a convenient means of determining the value of any one of the variable factors in the formula horse-power $= 0.0003\ dWN$ for the straw-fiber friction wheel working in combination with an iron follower, the remaining factors being known or assumed. To transform values thus found to corresponding ones for the other possible combinations of wheels, it is only necessary to multiply by the proper factor chosen from the table of multipliers given with the chart.

Application of Results to Forms Other than Those Experimented Upon —Face Friction Gearing

A fibrous driving wheel, acting upon the face of a metal disk, constitutes a form of friction gear which is serviceable for a variety of purposes. If the driver is so mounted that it may be moved across the face of the disk, the velocity ratio may be varied and the direction of the disk's motion may be reversed. The contact is not one of pure rolling. If the driver is cylindrical in form, the action along its line of contact with the disk is attended by slip, the amount of which changes for every different point along the line. The recognition of this fact is essential to a discussion of the power-transmitting capacity of the device.

Experiments involving the spur form of friction wheels already described have shown that slip greatly affects the coefficient of friction; that the coefficient approaches its maximum value when the slip reaches 2 per cent., and that when the slip exceeds 3 per cent., the coefficient diminishes. It is known that reductions in the value of the coefficient with increments of slip beyond 3 per cent. are at first gradual, although the characteristics of the testing machine have not permitted a definition of this relation for slip greater than 4 per cent. The experiments, however, fully justify the statement that for maximum results the slippage should not be less than 2 per cent. nor more than 4 per cent. It is the maximum limit with which we are concerned in considering the amount of power which may be transmitted by face friction gearing.

From the discussion of the previous paragraph, it should be evident that, for

best results, the width of face of the friction driver and the distance between the driver and center of disk should always be such that the variations in the velocity of the particles of the disk having contact with the driver will not exceed 4 per cent. A convenient rule which, if followed, will secure this condition, is to make the minimum distance between the driver and the center of the driven disk twelve times the width of the face of the driver. For example, a driver having a ¼-inch width of face should be run at a distance of 3 inches or more from the center of the disk. Similarly, drivers having faces ½, 1 or 2 inches in width should be run at a distance from the center of the disk of not less than 6, 12 or 24 inches, respectively. When these conditions are met, all formulas for calculating the power which may be transmitted apply directly to the conditions of face driving.

It may not infrequently happen that friction wheels must be run nearer the center of the disk than the distance specified; there is, of course, no objection to such practice, but it should not be forgotten that as the center of the disk is approached, the coefficient of friction, and consequently the capacity to transmit power, diminishes.

Conditions to Be Observed in the Installation of Friction Drives

Whatever may be the form of the transmission, the fibrous wheel must always be the driver. Neglect of this rule is likely to result in failure which will appear in the unequal wear of the softer wheel, occasioned by slippage.

The rolling surfaces of the wheel should be kept clean. Ordinarily they should not be permitted to collect grease or oil, nor be exposed to excessive moisture. Where this cannot be prevented, a factor of safety should be provided by making the wheels larger than normal for the power to be transmitted.

Since the power transmitted is directly proportional to the pressure of contact, it is a matter of prime importance that the mechanical means employed in maintaining the contact be as nearly as possible inflexible. For example, arrangements of friction wheels which involve the maintenance of contact through the direct action of a spring have been found unsatisfactory, since any defect in the form of either wheel introduces vibrations which tend to impair the value of the arrangement. It is recommended that springs be avoided and that contact be secured through mechanism which is rigid and which when once adjusted shall be incapable of bringing about any release of the pressure to which it is set.

An English Universal Grinding Machine

A Machine Tool Embodying Some Interesting Features of Construction, Built by a Well Known British Firm of Engineers

BY J. E. STOREY*

The universal grinding machine built by the Newall Engineering Company, Limited, Warrington, England, has been so designed as to make it capable of turning out plain cylindrical grinding rapidly; at the same time, none of the features desirable in a universal grinder have been abandoned. Particular regard has been paid to the necessity for changing the machine from one job to another, involving some interesting features in the design. It is, for instance, possible for the operator in front of the machine, without moving from the position he is standing in, to perform all the adjustments necessary to change the machine. These adjustments include: Starting or stopping of the wheel; starting or stopping of the work; varying the speed of the work from 37 to 550 revolutions per minute by the operation of a lever; altering the traverse of the table from 0.054 inch to 0.375 inch per revolution of the work, also by the operation of another lever; altering the distance apart of the headstock and tailstock, which have self-contained clamping arrangements; altering the distance apart of the reversing dogs, which have a novel arrangement for gripping; throwing in or out the automatic wheel feed, which is capable of adjustment to give cuts from a quarter thousandth to four thousandths and is provided with an automatic knock-off; throwing in or out the power feed to the traverse. All these adjustments can be performed without the operator moving his position and without the necessity of a spanner. The half-tones, Figs. 1 and 2, show the front and back of the machine respectively, while the line engravings give the details.

*General manager, Newall Engineering Company, Limited.

General Construction

The machine is of rigid construction and of the type where the work moves across the face of the wheel. The wheel head is fed into the work in the usual manner and has compound swiveling slides to enable it to be set to any angle. It is counterbalanced to take up vibrations. The slide carrying the wheel head is extra long, and the male and female portions are of equal length in order to insure equal wearing. The table swivels on the slide and can be set to grind tapers up to 4 degrees or 2 inches per foot.

Wheel Head

Details of the wheel head are shown in Fig. 3. From this it will be seen that a grinding wheel 12 inches diameter by ¾ inch wide is carried on one end of the spindle. The seat on which this is mounted is dished so that there is no overhang of the wheel. By this arrangement the wheel may be quickly removed and replaced. The spindle, which is made of hardened steel, is run in two phosphor-bronze bearings. These bearings are conical and split, nuts being provided at each end for adjustment. The cavities in the seats of these bearings provide ample room for oil.

A novel feature in the design is in the thrust adjustment. Referring to the drawing, *A* is the nut for the adjustment of the right-hand bearing. This nut is of hardened steel and is extended so as to form a face for the thrust of the spindle. The thrust is taken by hardened-steel washers on either side, *B* butting against the shoulder on the spindle, and *C*, on the other side, against the nut *D*, which can be locked by the screw *E* after adjustment. The great speed at which grinding-wheel spindles have to run makes them liable to get more or less warm, causing expansion in the metals; but this expansion will have practically no effect upon the arrangement described, as the length involved is only a matter of about ⅛ inch or so. The whole of this thrust adjustment is incased by the cap *F*, which forms an oil well and prevents the interference of dust.

Wheel Slide

Fig. 4 shows the arrangement of the wheel slide and details of the method of preventing dust from reaching the wearing surfaces of the slides. This arrangement consists of a telescopic dust cap in three parts. The front piece *A* is fixed to the front of the bottom slide, while the back piece *B* is attached to the top slide by the strip *C*, allowing it sufficient movement to pass over the nose of the top slide. The intermediate piece *D* is free to pass over the front piece *A* and into the back piece *B*. In this case the amount of movement is limited by the feather screws *E* and *F* in the slots *H* and *J*. These telescopic guards exclude both dust and

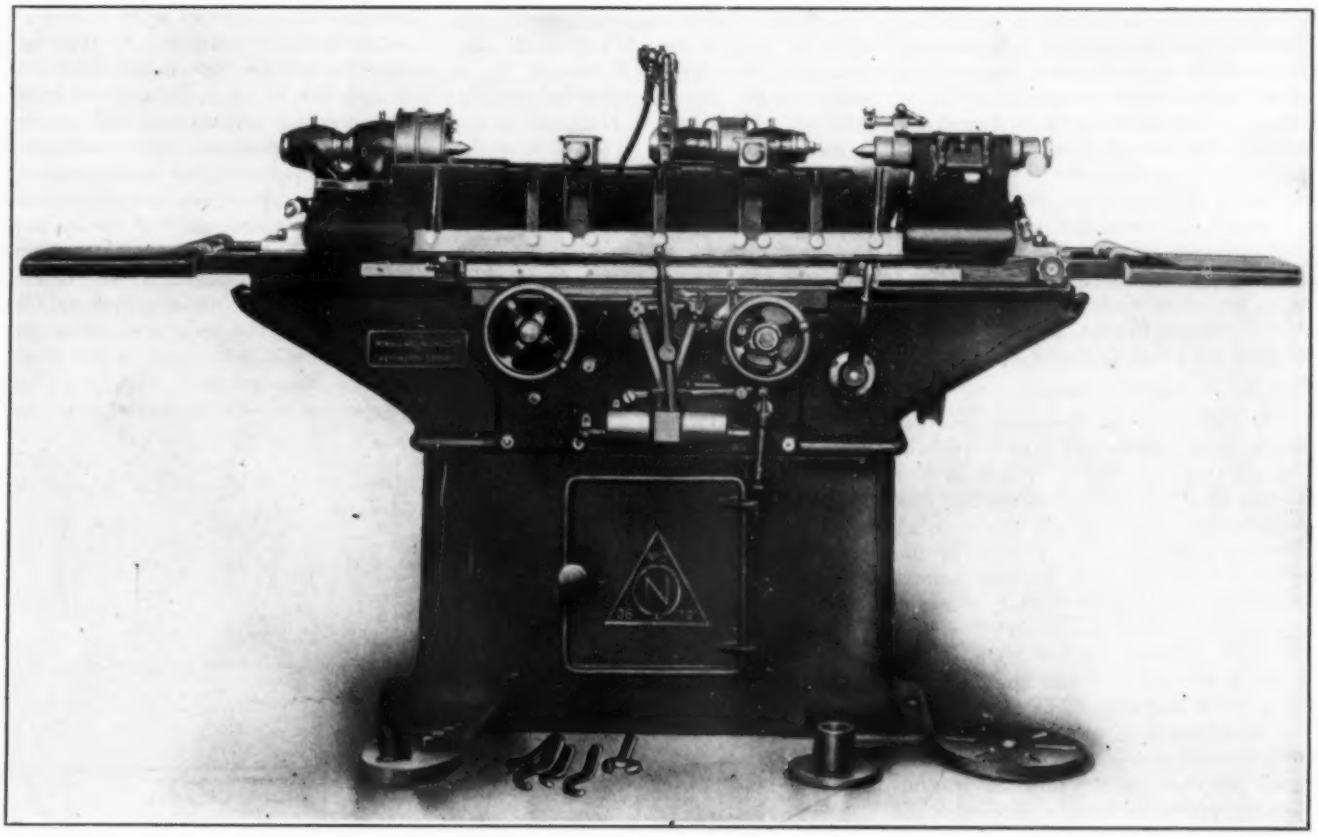


FIG. 1. FRONT VIEW OF NEWALL UNIVERSAL GRINDING MACHINE

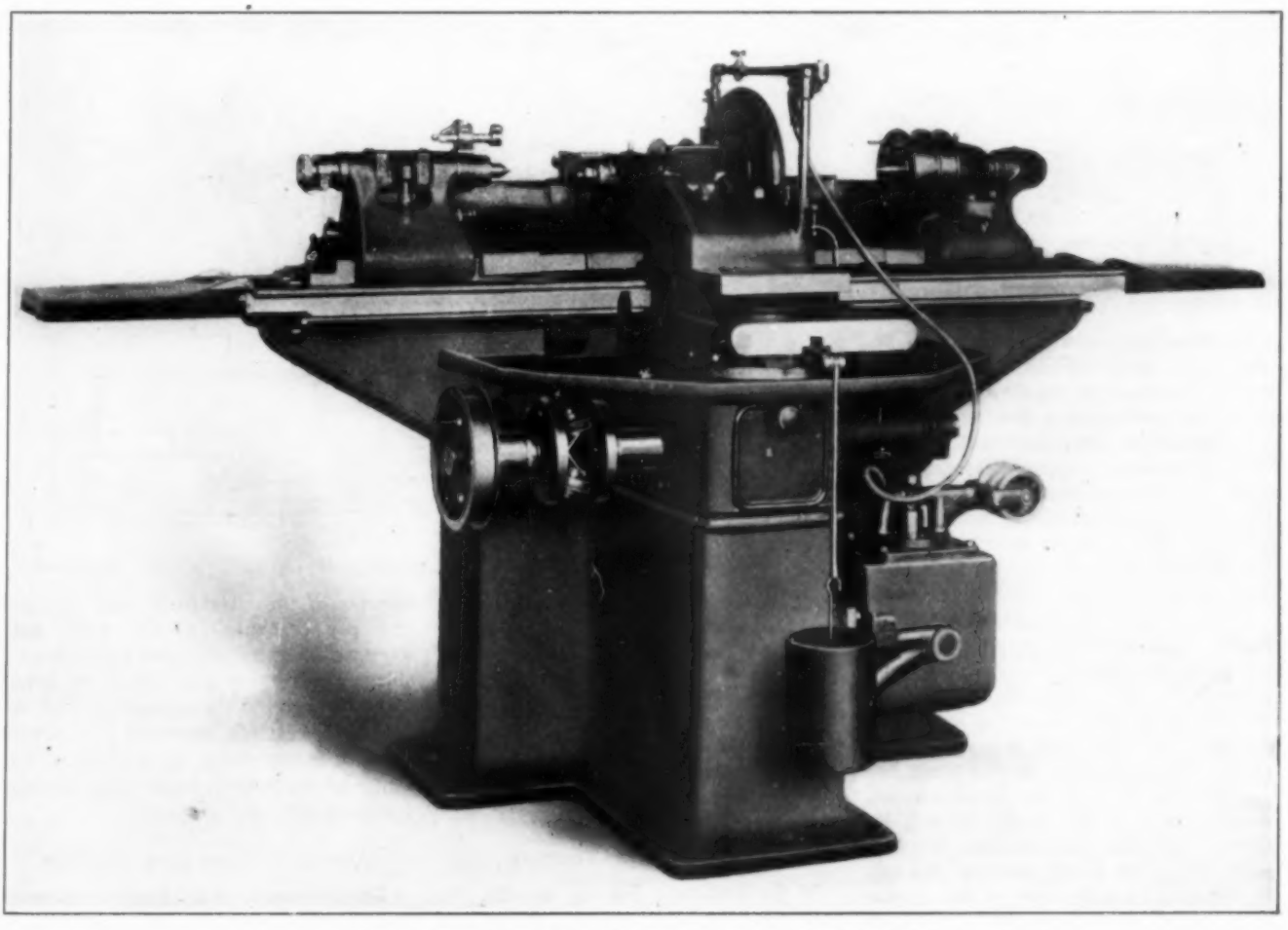


FIG. 2. REAR VIEW OF NEWALL UNIVERSAL GRINDING MACHINE

water from the slides and, although the slides have a movement of 6 inches, the amount taken up by the dust guards is so small that the position of the slides is brought much farther forward than would otherwise be possible, thus increasing the support of the grinding wheel. As will be seen from the illustration, the wheel head can be swung round independent of the slide, and the base of the slide is also graduated so that it can be set to feed in at any desired angle. The slide is counterbalanced to take up backlash from the feed gear and to absorb vibration.

The Headstock

The outline of the headstock and the details of the spindle and dead-center pulleys are shown in Fig. 5. The headstock is clamped to the table by an eye bolt in a diagonal slot. The eye bolt works on an eccentric shaft which is operated by the lever *A*. The eye bolt is fitted with a screw head and a plate washer, *B* and *C* respectively. They are provided with a cup seat so that any alteration in the angle of the eye bolt will not bring the strain on to one edge. The screw *B* may also be adjusted so as to bring the gripping moment of the lever *A* into the desired position. As the tailstock is similarly equipped, this forms a very quick and convenient arrangement.

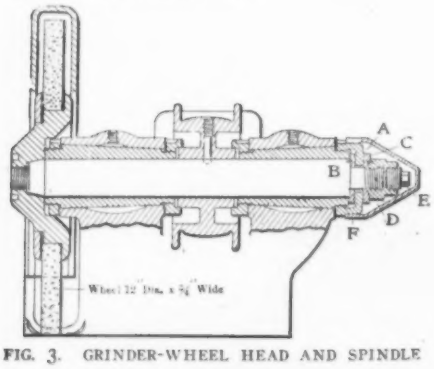


FIG. 3. GRINDER-WHEEL HEAD AND SPINDLE

The headstock, it will be seen, can be swiveled in the usual way and is graduated in degrees. The spindle and bearings are of the same construction as those in the wheel head, being hardened steel in phosphor bronze. Three pulleys are provided, two of equal size and one smaller. The large inside one, being fixed to the spindle, is for live-center and chuck work. For dead-center work two sizes of pulleys are provided, the larger one fitting over the smaller. In this arrangement the thimble *D* is of steel. It is retained in the pulley by means of the phosphor-bronze bushing *E*. The bush *E* is screwed into the small pulley *F* and is locked by the screw *G*. This bush is a running fit on the thimble *D*, a thrust adjustment being obtained against the flange on the thimble, seen at the front. It will be noticed that this arrangement is dust proof; the whole is self contained and can be removed from the nose of the spindle by inserting pins through the holes shown at *H*. The large pulley *J* fits on the flange of the smaller pulley and is retained in its place by three screws fitting in the key slots *K*. One of these screws, *L*, has a smaller head than the other two and is provided with a spring. The head of this screw fits into recesses at the back of the key slots. To remove the large pulley, all that is necessary is to press the screw knob *M* and give the pulley a slight turn backward in order to bring the heads of the screws opposite the large openings in the key slots. The pulley may then be withdrawn, leaving the small pulley available for use.

When the dead-center pulleys are in use, the spindle is kept from rotating by a pin fitting in the recesses in the back of the fixed pulley shown at *N*.

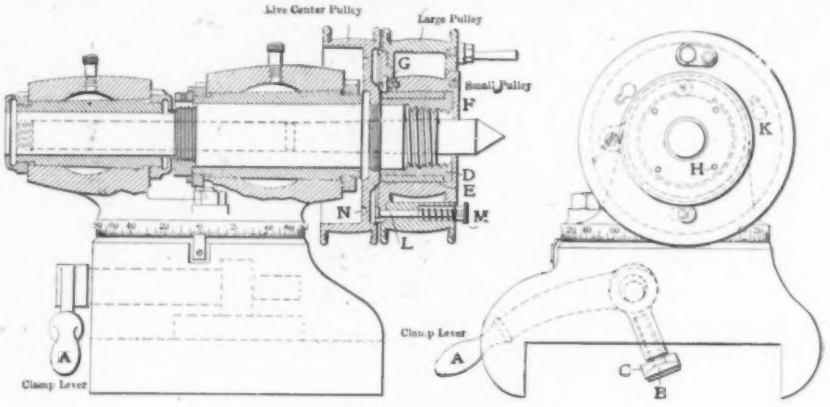


FIG. 5. HEADSTOCK OF GRINDER

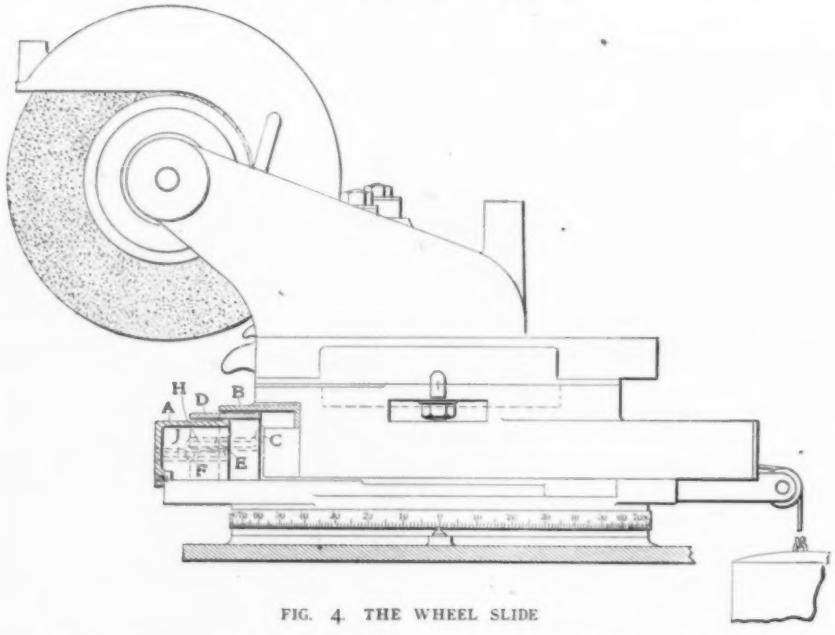


FIG. 4. THE WHEEL SLIDE

The Tailstock

No line illustration is shown of the tailstock, but its general construction can be seen from the general views, Figs. 1 and 2. It can be used either for spring-center work, or the spindle can be locked and the screw feed to the center used.

The Automatic Traverse

In the half-tone, Fig. 2, showing the back left-hand view of the machine, the variable-speed friction gear can be seen. This gear consists of two disks with concave faces which work face to face but revolve in opposite directions. The first disk is driven by the pulley and belt from the countershaft and transmits the motion to the opposite disk through two vulcanite flanged wheels, revolving freely between the two disks. The speed of the first disk is constant, but the speed of the second disk depends of course upon the angle at which the vulcanite-covered wheels are set. The ratio obtainable by this gear is about 7 to 1. The lever controlling the traverse speed can be seen in the front view of the machine, Fig. 1. This arrangement permits of variation in the traverse of the table from 0.054 to 0.375 inch per revolution of the work, any intermediate speed of course being obtainable. The friction gear drives the bevel reversing gears at the opposite end of the bed, and a clutch operating the power traverse is controlled by a knob in the center of the traverse hand wheel (on the left-hand side of the apron).

Automatic Cross Feed and Trip

The automatic cross feed is operated through the lever *A*, shown in Fig. 6. This lever has two side arms which are

oscillated by the movement of the reversing dog. Mounted on trunnions at each end is a nurled nut *B* by which the plungers *C* and C_1 may be adjusted for length. The two plungers *C* and C_1 operating through the horizontal lever *D*, impart the motion to the twin pawls *E* and E_1, operating on the ratchet teeth of the feed wheel *F*. The drawing shows the device at the moment of reversing, the maximum feed having been applied. As soon as the dog begins to leave the levers, the spring, acting upon the horizontal lever *D*, forces the whole gear up to a stop; it rests in that position until the dog operates it from the opposite hand. The amount of movement imparted to the horizontal lever *D*, and so the amount of the feed, depend upon the length of plungers *C* and C_1. As the length of the plungers is shortened by the adjusting nuts, so is the amount of the feed reduced. Twin pawls are used so that a coarser pitch of ratchet wheel may be employed, the two pawls permitting a feed equal to half a tooth. The disk *G*, on which the ratchet wheel is mounted, is graduated to quarter thousandths of an inch; it carries the pin *H*, which throws out the automatic feed by lifting the trip trigger *J* and allowing the feed lever *K* to withdraw the pawls from the ratchet wheel. A fork *L*, attached to the feed lever *K*, withdraws the pawls as the feed lever falls to the left. Connected to this feed lever is also a link motion which withdraws the hammer *M* so that it entirely misses the dog; the whole feed mechanism is then out of operation. To start the feed, all that is necessary is to push the feed lever to the right until the trip trigger drops into position over the catch pin *N*. The two pawls are kept in contact with the ratchet wheel by spring points thrusting against the heel of the pawl shown at *O*, and either or both of them may be withdrawn from the ratchet wheel without disturbing the feed lever. The disk on which the ratchet wheel is fixed is a free fit on the hand-wheel shaft, and the motion from the ratchet wheel to the hand-wheel shaft is transmitted through friction rollers on inclined planes. On that account the hand wheel can be used to feed in the grinding wheel, although the automatic feed is in operation. It also permits of another convenient arrangement. If it is found when grinding a shaft that it needs, say, 0.015 inch to bring it to the desired size, the ratchet wheel is revolved until the graduation 15 on the disk on which it is mounted comes opposite a pointer attached to the apron. If the automatic feed is allowed to continue in operation, it will automatically knock off at zero. The entire feed mechanism can be thrown out of operation at any time by pressing down with the finger the end of the trip trigger *J*.

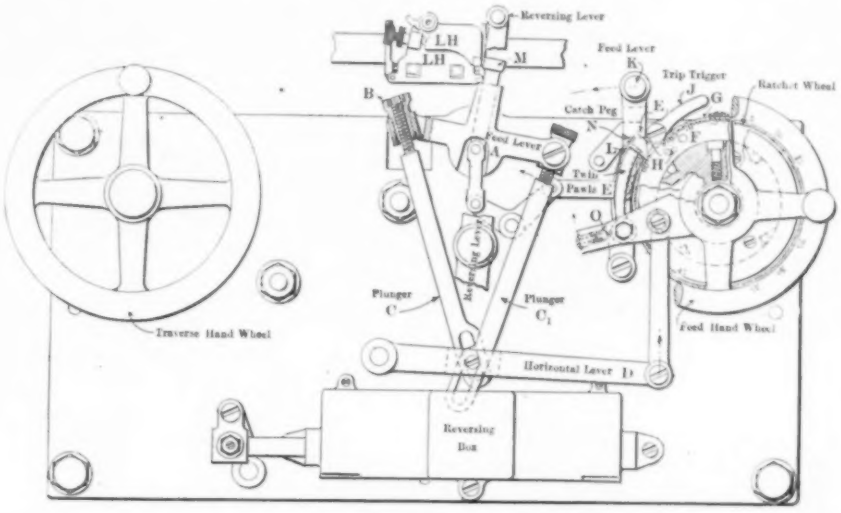


FIG. 6. GRINDER APRON AND AUTOM ATIC CROSS FEED AND TRIP

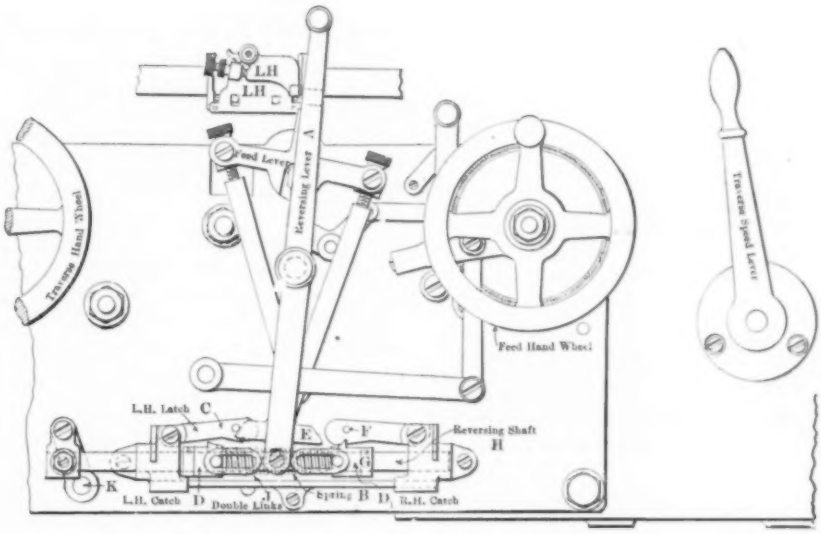


FIG. 7. AUTOMATIC REVERSING MECHANISM ON APRON

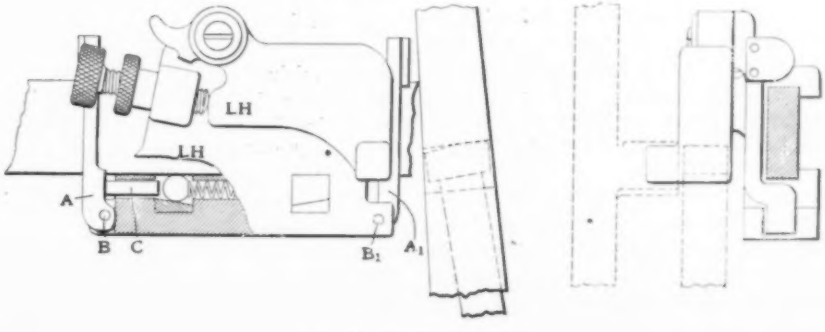


FIG. 8. REVERSING DOG

Reversing Gear

The reversing mechanism is shown in Fig. 7. In the position shown, the reverse has just taken place, having been operated by the left-hand dog. As the right-hand dog throws over the reversing lever *A*, the spring *B* is compressed until the left-hand latch *C* drops over the catch *D* against which one end of the spring is pressing. The left-hand latch drops over the left-hand catch, and immediately afterward the right-hand latch is lifted by means of the heel *E* provided at the foot of the reversing lever and the pin *F*. As soon as this relief is effected, it allows the spring to shoot forward in one direction only, thrusting against the opposite latch, carrying with it the right-hand catch D_1; this, being in contact with the collar *G* on the shaft *H*, performs the reversing movement. The right- and left-hand catches *D* and D_1 fit freely on the shaft *H* and are provided with trunnions on either side; these trunnions fit freely in slots in the double links *J* on either side of the spring. The compression of the spring is effected

by the reversing lever operating through the double links and drawing one of the catches with it. The other catch remains stationary, as also does the reversing shaft *H*, until the latch is lifted. The shaft operates another shaft *K* at right angles to it, and this shaft in turn operates the reversing clutch between bevel gears running in opposite directions. This arrangement is very positive and regular and permits of work being ground up to a shoulder.

Reversing Dog

A novel application of a friction roller on an inclined plane as the means of gripping will be seen in Fig. 8, illustrating the reversing dogs. The dogs are carried on a rectangular bar secured to the work slide of the machine. Two rollers, acting between two inclined planes in opposite directions on the dog and the bottom side of the rectangular bar, effect the grip. A spring, thrusting between the two rollers, keeps them up the inclines, and the dogs cannot be moved in either direction until the rollers are displaced. The levers *A* and A_1 at each end of the dog carriage are pivoted at *B* and B_1; when either of these levers is pushed inward, the corresponding roller is displaced by the pin *C*. By gripping the two levers between the finger and thumb, the dog carriage may be moved in either direction along the rectangular bar. Immediately the levers are released, the grip is effected and it is impossible to move the dogs by any fair means.

As will be seen from the illustration, the drop latch is provided with screw and lock nut for fine adjustment. The drop latch may also be lifted to avoid contact with the reversing and feed levers, but the ease with which the dog carriage is moved renders this almost unnecessary.

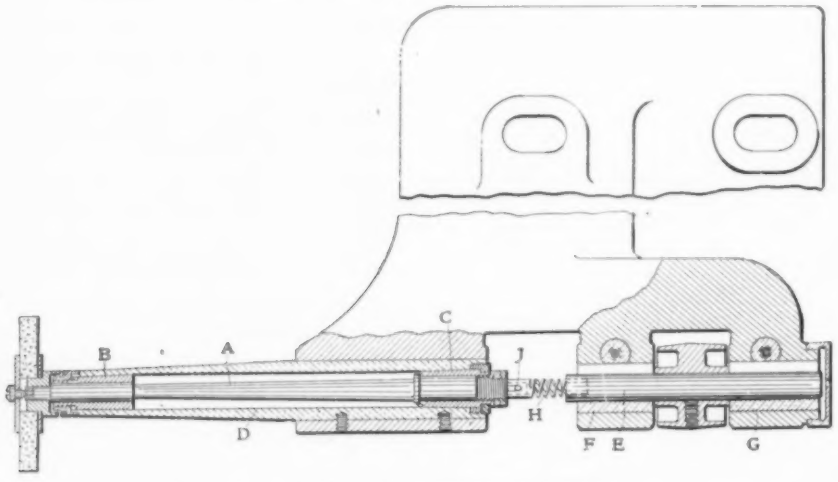


FIG. 9. INTERNAL GRINDING ATTACHMENT

Internal Attachment

The internal grinding attachment for the Newall machine is shown in Fig. 9. The grinding wheel is carried on a long spindle *A*, which runs on the bearings *B* and *C* at each end. Either of these bearings may be adjusted to take up wear, as they fit in conical slots and are split. The spindle and bearings are contained in the socket *D*, which may be quickly removed from the internal attachment when it is necessary to adjust the bearings. The driving spindle *E* is in line with the grinding-wheel spindle, but is run on independent bearings *F* and *G*. The motion is transmitted from the driving shaft to the grinding-wheel spindle by means of the spring coupler *H*. This coupler being flexible, practically none of the strains introduced by the pull of the belt, error in alinement due to wear or other causes, is transmitted to the grinding-wheel spindle. The spring coupler is fixed in the driving spindle and slides over the reduced end of the grinding-wheel spindle, the end being slotted to fit over the key *J* so that the socket containing the grinding-wheel spindle may be removed at will.

Back Rests

An examination of the direction of rotation of the grinding wheel and the work, and the strains introduced by the abrasion, shows that in order to overcome the resulting vibration, pressure in two directions is necessary and with separate adjustments, as the pressure required in one direction is greater than in the other. The drawing, Fig. 10, shows how these requirements have been met in this grinder. In this the sliding block *A* is thrust forward against the work by means of the screw *B*. The screw fits in the socket *C*, which is a sliding fit in its recess. It has a feather key to prevent it from rotating. A spring *D*, thrusting between the shoulder on the socket *C* and the adjusting nut *E*, maintains the forward pressure through the screw *B* on to the sliding block *A*. This pressure can be increased or decreased as desired by the thumb screw *E*, and the sliding block is adjusted to accommodate different sizes of work by means of the screw *B*.

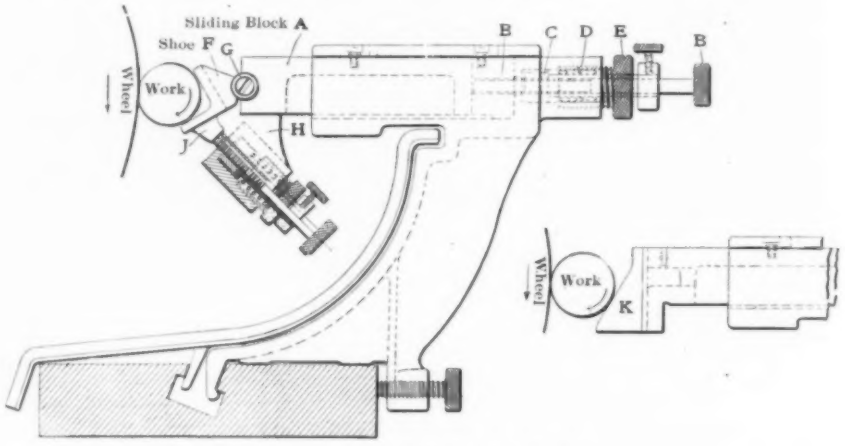


FIG. 10. UNIVERSAL STEADY REST

On the front of the sliding block *A* is a gun-metal shoe *F* which is pivoted at *G*. The bracket *H*, at the front of the sliding block, contains a spring arrangement. This is of the same construction as the one used on the back of the sliding block, and is used to apply pressure to the work in the second direction required, through the heel *J* on the shoe *F*. For suitable classes of work the whole sliding block may be removed and another one substituted with a shoe of the type shown at *K*.

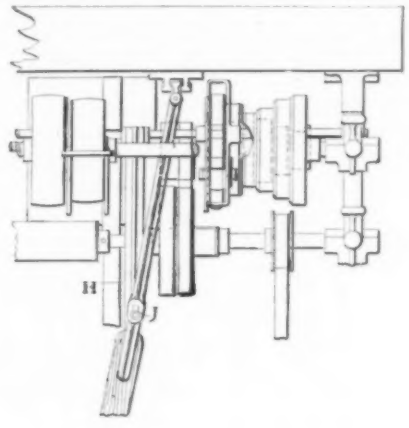
Cone-pulley Belt Shifter

A simple and effective arrangement for varying the speed of the work is adopted in the countershaft. Referring to Fig. 11, *A*, *B* and *C* are the three shafts on the overhead work. *A* is driven from the main shaft and drives the grinding-wheel shaft *B*, by means of cone pulleys, not shown. Another cone pulley *D*, on the shaft *A*, drives its mate *E*, which is a running fit on the shaft *B*. It runs in the same direction as the shaft, but at various speeds. Attached to the cone pulley *E* is the pulley *F* which drives on to the fast and loose pulleys on the work shaft *C*. By the arrangement of the jockey pulley *G*, which runs on the slack side of the belt, and the levers *H* and *J*, the belt can be moved from one step on the cone to another. The jockey pulley is carried on

rod *K*, as also is the lever *H*. The jockey-pulley bracket has also front and back belt forks *L* and *M*, which guide the belt to the steps. When operating the shipping lever to the left or the right, the pressure on the slack side of the belt can be either increased or decreased as desired, according to whether the tight side of the belt is going up or down the cone. The weight of the shipping levers acts as a counterbalance to the jockey pulley.

ACCESSORIES

The machine is fitted with a pump which, as can be seen from the illustration showing the back of the machine, is attached to a tank mounted on pivots,



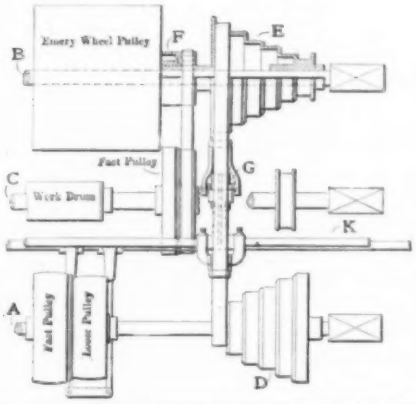


FIG. 11. ARRANGEMENT OF COUNTERSHAFT

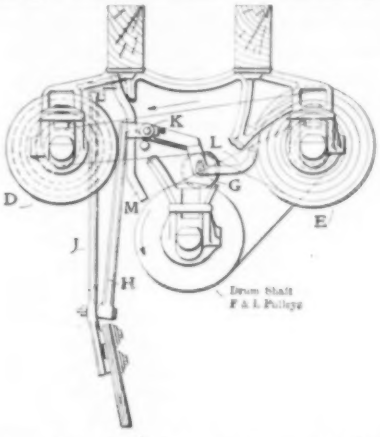
making a convenient arrangement for emptying and cleaning. The accessories include a full line of splash guards, back steady rest, center steady rest, chuck, drawback collet and carriers.

Consul-general Richard Guenther, of Frankfort, says it is reported that a Hamburg joint stock company has purchased a large tract of land along the mouth of the Elbe at Cuxhaven where power works are to be erected. The action of the ebb and flow of the tide is to be employed in generating electric energy to be used in factories about to be established. The works will also furnish electric power to the town of Cuxhaven and other towns in the vicinity. The daily capacity of the plant will reach 14,000 horse-power. Tests are said to have established the feasibility of this method of generating electricity.

A Question in Engineering Ethics

BY ENTROPY

Here is a question of ethics that I should like to know about. A few days ago I was staying at home sick. I had just crawled out of bed, about noon, when one of my neighbors called to ask me to go over and see what was the matter with his pump. He said he had heard I was an engineer and he hoped I could fix it. If I couldn't, he would have to send to New York for a man to come and set it going. Now this man is managing a



large stock farm for one of my neighbors, so I had a sort of brotherly feeling come over me, in spite of the fact that I felt more like going back to bed than hiking over the hills for a mile. I got on a few clothes, or what pass for clothes out here in the backwoods, and went over, after assuring my neighbor that I had once successfully started up an engine. I did not tell him that I stopped it on the dead center; he did not ask, and I did not feel in a conversational mood.

When I got over to his pump house, I was surprised to see that he apparently had a gasolene engine to run it, for this place is farther behind the rest of the world than the time of the gasolene motor. He explained that it was a kerosene burner, had been sent up from New York and that he and his machinist had spent all the previous day trying to make it pump. I found the pump to be a Gould triplex or something of that sort. As I know a man that used to work in Seneca Falls and I once went through there on the cars, I felt quite at home and began to look it over. "No, no," he said; "It is this part," pointing to the engine; "that part is all right." Well, here I was stumped. I once saw a Shipman kerosene engine in a second-hand store, but this one was something new. I had to get time to think, so I asked him if he could get off the cylinder head while I rested. While he was at it, I sat down on a log, held my stomach with one hand, my head with the other and looked as sick as I could. Yet I squinted out of one eye at a diagram of the engine that was hanging on the wall. I soon had the combination clear in my mind.

The machine was just like a gas engine except that, instead of using a carbureter, they just squirt a little kerosene into the cylinder at every other stroke. They explode the kerosene (and air) with a red-hot plug in the back of the cylinder. If everything is just right, the kerosene gets mixed with the air that is drawn into the cylinder on the out stroke in time to compress enough to explode well, when it ought to, to drive the cylinder on its next out stroke. I'll bet the fellow that got up this engine had a great time getting the second one to go. The first one must have just happened right or he never would have had the patience to make it go at all. On top of the cylinder there was a little bit of a force pump that sprays the kerosene. I noticed that this pump was operated by a cam which pushed the plunger in, but left it to be pulled back by a spring. When the man got his head off (the cylinder head, of course), I looked into the cylinder to see how the kerosene squirted in. I worked the pump by hand and it seemed to go all right, but I noticed that the plunger seemed to hesitate about coming back.

"How fast does this thing go?" I asked. "About 600," he said. At 600 revolutions I could not see how the pump plunger was going to get out at all. I told him to wipe out the mouth of the exhaust port. It looked dirty, but I guess it was its natural color, and I unscrewed the stuffing box on the pump a few turns while he was not looking. Then I told him that I thought the engine was all right anyway, that he probably had spoken unkindly to it or something; would he please bolt it up and let me try to start it? He looked rather skeptical, but I told him that I could tell more about it by trying it once than I could by looking it over all day. Well, it started up and ran all right. I told him it was just as I thought, the engine would not go till the right man started her, and if he ever had any trouble again to telephone down to the shop and I would speak kindly to it, and it would run. He wanted to know what he should pay me. I told him that, if he would get his team out and take me home, I would call it square.

Now for my question! What ought I to have charged him? Remember, first, I was at home and not getting anything for my time; second, I did not know anything about oil engines; third, any boy could have done all I did in three seconds. Yet on the other hand, first, I performed a real service; second, it would have cost him $50 to get a man from New York; third, it would have discredited him in the eyes of his employer to have had to send away for help; fourth, there is plenty of money at his disposal.

What do you say?

Locating Holes Accurately in Special Tools*

The Accomplishment of Close Work on the Milling Machine by Using Verniers to Check the Distances from Hole to Hole

BY J. G. VINCENT†

Several years ago when working at the toolmakers' trade, I had to make a number of very fine perforating dies, also a number of drill jigs. All the holes in these tools were to be accurate to within one-thousandth of an inch, and from past experiences I knew I could not trust the graduations on the screw of the milling machine which was available. In fact, I might state that on numerous occasions I have tested the accuracy of milling-machine screws and have never yet found one good enough to be used where work had to be exact to within one-thousandth of an inch.

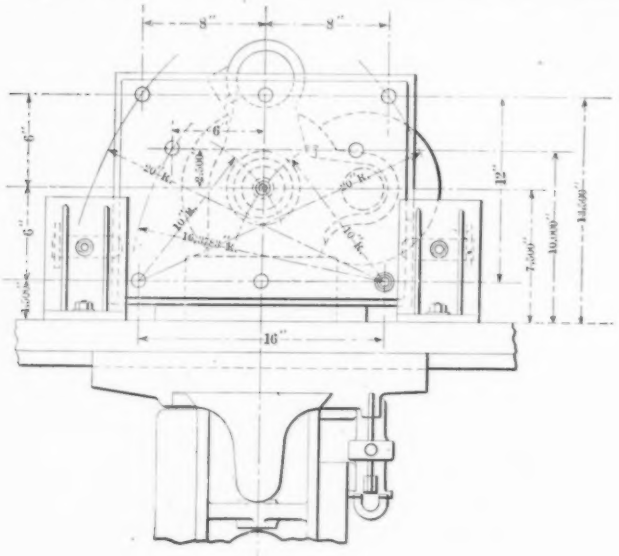


FIG. 1

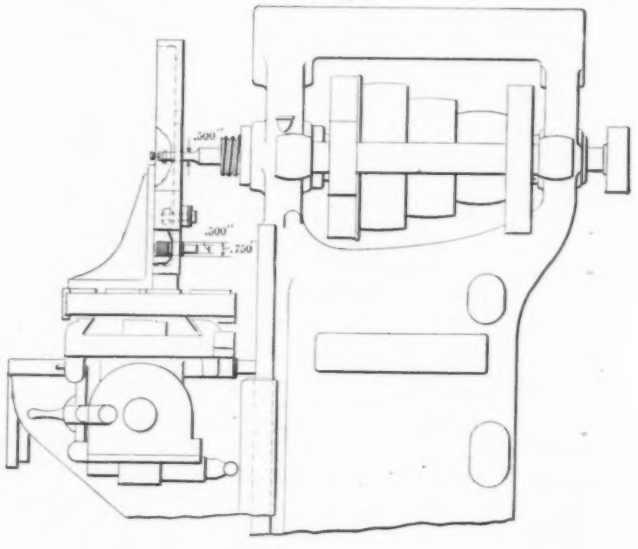


FIG. 2

LOCATING HOLES ACCURATELY IN SPECIAL TOOLS

The Character of the Work

The tools to be bored were of such dimensions that it was necessary to clamp them up on an angle plate on the milling-machine platen in order to get sufficient travel of the platen in both directions to cover the extreme holes to be bored. This made the problem of locating the holes accurately more difficult than it would have been had I been able to clamp the tools down flat on the platen and use the vertical head of the miller to carry the boring tools. A moment's consideration will show why this statement is true. With the tool to be bored clamped upon edge, it was necessary to adjust the knee of the milling machine up and down a sufficient amount to take in both the lowermost and uppermost holes, and this adjustment of the knee resulted in throwing the work out of square. It would, of course, seem that, with the gibs of the milling machine nicely adjusted, it should be possible to raise and lower the knee without throwing it out of square; but the fact remains that when a tool of rather large area is to be bored, thereby necessitating a considerable movement of the knee as well as a considerable longitudinal movement of the platen, the work will be thrown out of square owing to various conditions of overhang and slight errors in the milling-machine construction.

How the Plate was Held

In sizing up this problem, I therefore decided that not only must some way be devised for accurately spacing the platen lengthwise, and also accurately spacing the knee up and down in order to locate the holes properly, but that also some method had to be provided for checking the holes in a manner to guard against overhang of the knee and platen. I finally decided to use the following arrangement, and it worked out very satisfactorily:

Figs. 1 and 2 illustrate the manner in which the plate to be bored was clamped on the milling machine. It will be noted that a parallel strip is placed under the plate in order that the lowermost hole may be a sufficient distance from the platen to facilitate measuring. In securing the jig plate in this position, two angle plates were used, one at each end, in order that none of the holes to be bored should be obscured. In order to facilitate the work, the holes were laid out roughly and drilled to within a sixteenth of the finished size before the jig plate was clamped on the milling machine, thereby making it unnecessary to remove the boring bar after the job was completed. It would be better practice, however, to rough drill the holes by using a drill in the spindle of the milling machine, locating the holes by means of the dials on the screws, thereby locating them quite accurately and economically and leaving very little stock to be taken out during the final boring operation. In this case the holes could be rough drilled to within a thirty-second of the finished size and still leave plenty of stock for finish boring.

The Sweep Indicator and the Test Plugs

In clamping the jig plate on the milling machine as just described, a sweep indicator was used in the milling-machine spindle to insure the location of the jig plate at right angles to such spindle, paper being used to shim up between the jig plate and the angle plates.

In order to illustrate clearly the principle involved, I have shown in Figs. 1 and 2 an imaginary jig plate in which eight holes are to be accurately located,

*Copyright, 1907, by Hill Publishing Company.

†Superintendent of Inventions, Burroughs Adding Machine Company.

according to figures. To simplify the explanation, I have assumed that all the holes were to be bored 0.75 inch in diameter; in view of this fact, it is only necessary to have one special plug, such as is shown in the lower right-hand hole (Fig. 1). It is to be understood, however, that where the holes to be bored vary in size, it is necessary to have special plugs, the larger diameters of which correspond to the holes to be bored, while their smaller diameters are all of the same size, such smaller size corresponding in diameter to the diameter of the boring bar.

I have found a boring bar of 0.500 inch diameter a good size for all-around work, and the smaller ends of all the special plugs are therefore made 0.500 inch to correspond.

As shown in Fig. 1 it is necessary to have the length of the hypotenuse of the angles between the different holes. The solving of this should be done in the drafting room and a drawing of the jig plate made with dimensions along the lines shown in Fig. 1. When I was working on the jigs mentioned, however, I had no drawing, except one of the part the jig was to make, and I had to solve the dimensions as the work proceeded. This can readily be done if the toolmaker is fairly proficient in mathematics, but it is the best practice to do this work in the drawing room, care being taken to give the dimensions in such manner that the toolmaker can work directly to such dimensions without complicated calculations.

Boring and Checking the Lower Holes

After the work had been set up as just described, I proceeded to bore the holes as follows: First the lower right-hand hole was bored to the finish size and then the special plug gage, as shown in Fig. 2, was inserted, it being understood, of course, that I used the cross feed of the miller to do the feeding. After this hole was bored, the platen was moved lengthwise to bring the work in position to bore the lower center hole. In making the final adjustments preparatory to boring this hole, the distance between this hole and the center one just finished was located with a vernier caliper by measuring from the plug and the boring bar, it being understood that in taking these measurements 0.500 inch was allowed for the two half diameters of the special plug and boring bar. The up and down distance was located with the hight gage by measuring under the special plug, with the hight gage setting by the platen, and then measuring under the boring bar. In this case these two measurements should be the same.

After the lower center hole had been bored, the platen was again moved in position to bore the lower left-hand hole; in making final adjustments preparatory to boring this hole, the distance was checked in the same manner as the center hole, a long vernier caliper being used in order to make it possible to measure from the initial hole at the right and thereby avoid accumulated errors. After boring the lower left-hand hole, the work was next lowered to position for boring the upper left-hand hole, and it is the means of checking the work to bring this hole in the correct relationship that I particularly want to illustrate.

How the Other Holes Were Located

By using a 6-inch cube which had previously been scraped to a true cube, it was possible to check the distance between the platen and the upper left-hand hole with the hight gage. In lowering the knee to bring the work in position for this upper left-hand hole, it would seem that the work would be lowered directly down and that no change of platen lengthwise would be necessary to bring the hole in the correct longitudinal position; but from previous experience I knew I couldn't trust the work coming right. Therefore I checked this dimension by solving the hypotenuse of the angle, which gave me the dimension between the initial hole bored and the upper left-hand hole, which, as shown in Fig. 1, is 20 inches. By carefully measuring from the special plug to the boring bar, I was enabled to check this dimension, adjusting the platen simply to bring the dimension correct. After this dimension had been checked, I again checked the vertical dimension to make sure this dimension had not been altered; then I was ready to bore the hole. I think it is apparent from the figures how all of the holes could be checked in the manner described. You will note, for instance, in boring the center hole of the plate, that I not only checked the hypotenuse from the initial hole, but also from the lower left-hand hole, as in this case both dimensions are the same.

Accuracy of the Process

In conclusion I will only add that I used this scheme of checking the work on numerous complicated jigs and dies, and I don't remember of ever boring a hole that was out to exceed one-thousandth of an inch. I remember that one perforated die bored in this manner contained fifty-six holes; after the die was completed, two plates perforated by it could be reversed and a plug inserted through all of the holes, thereby showing that the work was practically perfect.

According to *Engineering News*, comparative tests are to be made by the navy upon three fast "scout" cruisers — one equipped with reciprocating engines, one with Parsons turbines, and one with Curtis turbines. In the order mentioned, the vessels are the Birmingham, the Chester, and the Salem. The three ships are of the same design and have similar boiler outfits, each rated at 16,000 horse-power.

Organization and System for a Tool-drawing Room

By Albert C. Wead

There are so many manufacturers of machinery whose product involves a large production of interchangeable parts and who are demonstrating the economy of establishing departments for drafting and designing machine-tool fixtures and small tools, that much interest is manifested in the subject. Therefore, a brief outline, treating of the principal feature of tool and fixture designing and the management of such a department, seems opportune, not only to those who contemplate introducing such a department in their business, or have already done so, but to thousands of tool designers who are engaged in the work.

The success of a tool-drafting department depends considerably on good team work with the foremen of the manufacturing departments and the toolmaker's shop, as well as on a systematic organization covering special requirements, absence of internal friction, changing the men's work and good office methods. The man in charge of such an office should be one of unquestioned executive ability and in possession of technical experience, and yet practical enough to enable him to render the best solutions for the problems constantly arising. Simplicity of system should be the acme sought, since experience has shown that a system too complex or cumbersome will soon die a natural death from neglect or misuse by both the office and shop.

As to the system of a tool-drafting department, a card-record file should be established and should contain a complete record of all the tools used in the plant; the name of the tool, the drawing number, the date, the size of sheet, the designer's initials, the name or number of the piece upon which it operates, a report on its efficiency by the foreman who uses it, and the cost of making it. The two latter records will sometimes suggest a change in the design before that drawing is sent to the shop on a duplicate order. The record file allows anyone to review any one or all of the tools in use, and thus prevents the duplication of any of them uselessly. A better grade of tools and more uniformity is secured by designing all of the tools in the drafting office. When tools are laid out to scale, all the unforeseen difficulties in construction are met with on paper, which is cheaper than finding much more costly ones in steel. A tool drawing is more exact than any written or verbal order and is therefore the best method of giving information to the shop. It simplifies the labor of tool making, reduces the figuring in the shop to a minimum, eliminates to a degree the need of technical knowledge there and leaves the mechanic free to pro-

duce his best work in the shortest possible time. The tool-drafting office fills a real place in the general factory organization, between the executive and manufacturing branches. Other departments should expect as much valuable information from it as its advantageous position in the organization affords. The laying out of new work on the various departments where it can be handled best may also be one of its duties.

The Large Tool-drawing Room

If the office is large, comprising 20 or 30 men, it is well to subdivide it into departments, each with a foreman who is held responsible for his own section. Let one section handle all the punch and die work, another jigs and fixtures, another screw-machine tools and cams, another woodworking-machine tools, and so on, whatever the product of manufacture may require. A department for the design of special machinery is sometimes introduced in this connection with good results. It is most desirable that the designers who are engaged should all have had shop work; for those whose practical experience has fitted them for specialty work may soon be located in positions where their ability may produce the best economic results. The introduction of specialty work in the large concerns is not confined to the drafting office alone, but permeates the entire factory organization. It is probably an aid in retaining desirable help and obtaining more and better work, but affords a reason for so many failures of specialty men to hold positions in smaller manufactories. On the contrary, men from the smaller places usually succeed in the larger, and soon command more money; for specialty work pays the best salaries.

The Small Tool-drawing Room

If the office is small, it is usual to suppose that any of the designers are able to take up and develop any of the work. In such an office the man in charge is often the foreman toolmaker, if he has had some practical experience in drafting or possesses a large acquaintance with shop drawings. When the tool-drafting office is located conveniently to the toolmaker's shop, it is more suitable for both, preventing unnecessary visits between them. A like facility in reaching the blacksmith pattern shop or foundry is not so important.

Tool Drawings

An important consideration is the kind of drawings and their sizes; since there exist so many opinions in this matter, I will consider several of them. Tool drawings must be produced neatly, in concise arrangement, often in a very limited time and always in such a manner as to allow for unavoidable changes, which generally means frequent erasures. In some places tool sketches are made in pencil on medium-heavy cream drawing paper, with sizes of the sheets large enough so that most of the drawings may be laid out to a full-size scale. All dimension figures, arrow heads, notes or other lettering, including the title and stock list, are put in with black drawing ink. The work (or piece to be operated on by the tool) is dotted in with red ink, to show exactly how the tool is intended to be used. Changes are made in colored inks, marking out the old parts with the same color and giving the drawing a new date. With ordinary care on the part of draftsmen, who should make such changes as neatly as possible, the drawing will maintain a fairly good appearance even after four or five alterations. This system has some strong points and serves its purpose well for the small shop. As most of the sketches are drawn full size, the work of detailing all of the parts is unnecessary and time is economized. Pencil drawings are rapidly made, as are also the changes in colors. The original construction of the tool always remains visible, as well as all the successive alterations. Reasons for the various changes may also be shown in the same color by small lettering in an upper corner of the drawing, and this is an advantage as a matter of record. If such drawings are first inked in black, they will not become illegible after shop use, as pencil drawings sometimes do. The cream-tinted paper shows shop dirt less than the white and is generally not as expensive. It is true, however, that many difficulties are encountered when following this method in actual practice, especially when the drawings are handled by many persons. The most serious objections are found when they become torn, worn or lost, and a new one must be made from the tool to keep the office records intact.

A cheap way to avoid some of these annoyances, which has been resorted to in many drafting offices with partial success, is the use of tracing paper. A good bond tracing paper is obtained, upon which drawings are made with a soft pencil (2H or 3H is about right) and from which a readable blue print may be procured for the shop. The original drawings are thus kept clean and always in the office ready for reference; but, when these drawings are torn or worn through by erasures and patched, they make very unsatisfactory prints.

An ideal system for the tool drawing is the use of 9x12 and 12x18 sheets. Use tracing cloth, designing the work on it with pencil, and then trace over the lines with drawing ink. The sizes of these sheets will admit a large range of full-sized tool drawings, are convenient to handle and file, prints from them may be tabulated in book form if desired, and in the shop they cover such little space on the workman's bench that he will not fold them and cause the troublesome creases that blur out dimension figures. Make changes by erasure, with a note in the upper corner showing what the alteration was and why it was made. From these notes the clerk will know how to "charge out" the cost of making the changes. A space of suitable width, on the right-hand side of the drawing, may be inclosed between a vertical line and the border line for such notices.

A book containing general information may be issued for the office and shop, and should explain the system in vogue. It should show how to make the title, stock list and changes, how to designate patterns and mark the tools, how to indicate dimensions for very close work, when such are important and when not; should show sketches and dimensions of all the standard parts of tools kept in stock, the same for standard machines in all departments and the many other practical economies which time will bring forward in every establishment.

Conclusion

In conclusion the tool draftsman himself should have a fair consideration. His mathematical training, mechanical experience and inventive ability are frequently of a high order. The rules and regulations of his captains are varied; their approach to anything like a common standard is impossible, since their requirements are diversified, so that only a few common aphorisms are possible, which may interest the designer. He must know well the lines his pencil travels, or his own lines of endeavor may be broken and rocky.

1. Choose a size of drawing sheet so that the views, taken together, will appear proportional to it.

2. Fasten the sheet on a small drawing board lying loose on your desk. This is convenient when you wish to take your work to someone for consultation.

3. Lay out in red ink the piece to be operated upon. Make only the views sufficient to show the work and construction of the tool.

4. Design your tool or fixture to the piece and the operation required.

5. Do not show sectional views unless absolutely necessary. Sections are not easy to change.

6. On tool drawings all dimensions are understood to be in inches, therefore omit the inch marks (″). It makes the drawing look better.

7. Detail the parts in the same relative position in which they are assembled. It makes the drawing plain.

8. Do not put on duplicate dimensions. They often make trouble when changes are made.

9. Make neat drawings. Such have a tendency to get better work from the shop.

10. Cheap, simple and serviceable are the all important tool features to remember.

11. Good tools are made for use and not for display. Elaborate designs which show artistic cuts look well only on velvet in an exhibition show case.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Grinding a 22-foot Shaft on a 12-foot Machine

Having some shafts to finish, 22 feet long by 3¼ inches diameter, requiring extreme accuracy, and not being able to produce this on the lathe, I thought we would try this operation on our grinding machine, which was built to take 12 feet between centers. Leaving 1/16 inch for grinding, and not being able to use catheads, owing to the limited amount of space in the grinding-machine steady rests, we carefully spotted the shaft at the place where it was to be supported by the steady rests on the grinding machine (making this portion a perfect cylinder) for roughing and finishing the one end.

The shaft being prepared for grinding, we put a four-jawed chuck on the universal geared headstock and placed the shaft in the grinding machine. After chucking the shaft true and clamping six back rests on the table to absorb vibration and to insure parallel work, we proceeded to grind.

During the operation we experienced no difficulty whatever, in fact the machine worked just the same as if we had been grinding a shaft half as long, supported between two dead centers. The body of this end of the shaft being finished, we clamped a steady rest close to the end and ground the portion which was gripped in the chuck, turning the shaft by hand. This end being finished all over, we turned the shaft end for end, and adding two steady rests, as shown in the illustration, we proceeded the same as with the finished end. We did not grind this as rapidly as we would have in a 22-foot machine, owing to the amount of changes which had to be made.

From start to finish the time consumed was five hours. All things considered, we made better time and had a better job than we could have gotten in any other way.

Probably this job would have been impossible on a machine with a moving work table.

Waynesboro, Penn. J. H. HOLLINGER.

The Tool Designer's Troubles

The reasons the tool designer has his troubles are not hard to find when one considers the kind of knowledge they generally possess. I speak of the tool designer found in the ordinary machine shop of today.

The feeling of the machine designer toward the tool designer would be different than it is at present if the latter attended strictly to his part of the work, which is to design tools for the machine before him. For many times the tool designer asks or suggests changes in castings or parts that they may benefit him in the design of tools and not in the working of the machine. Looking at the commercial end of it from a shopman's point of view, it seems that the jig and tool designer is in many cases "an over-paid ornament," there being exceptions to this rule, of course. Why? In many cases he is an office employee or stenographer who has, at evening school, acquired a knowledge of drafting, and by the aid of a glaring advertisement and a great deal of nerve obtains a situation.

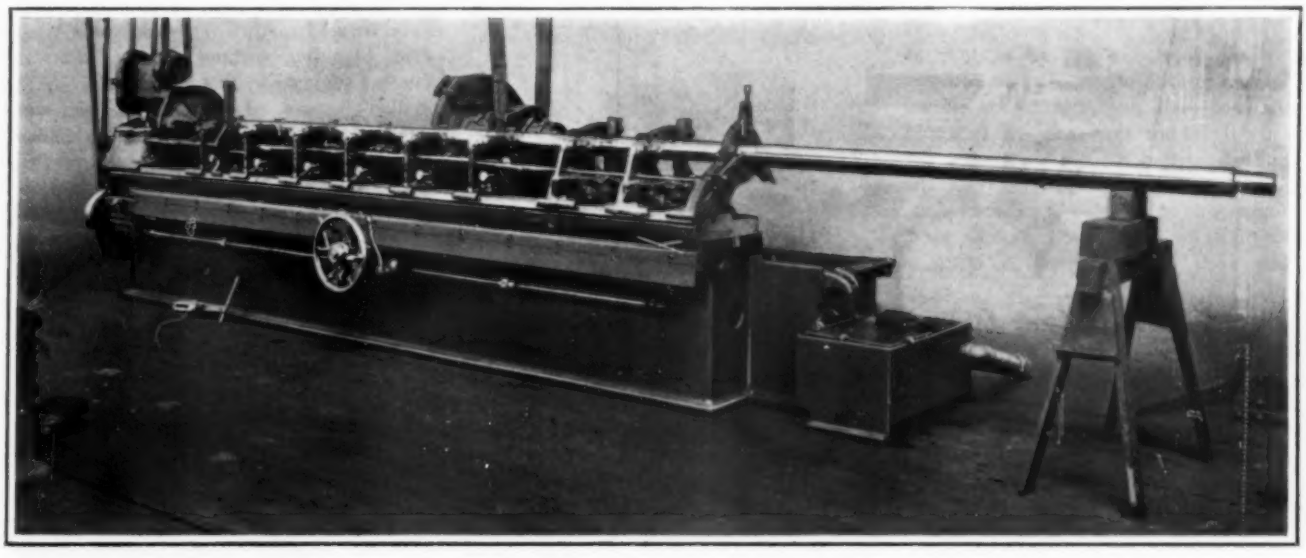
Mr. Baker states in a later paragraph that the tool designer tends toward conditions of specialization and the abolition of skilled labor and the all-around mechanic. This state of things must necessarily be the ground for the shopman's idea of the tool designer as a "malign influence," as they touch his pride and ultimately, and more forcibly, his pocketbook.

Having worked in a number of shops, I have seen jig and tool designers of all sorts from the promoted office boy to the three thousand dollars a year man. But the best plan I have observed is in a shop where the boss toolmaker had two draftsmen to work from his sketches. The jigs turned out in this factory were of the highest class, and seldom, it was that the tools did not give satisfaction. This department of the foreman's work did not interfere in any measure with his duty to the toolmakers under him.

There are many practical reasons why this mode is an efficacious and satisfactory one, the principal ones being:

The boss toolmaker is a man of experience and proficiency in his line of work, qualifications which fit him for the duties of a tool designer.

If he has worked with the firm any length of time, he understands its general machine and tool equipment and can save time and labor by this acquaintance.



CYLINDRICAL GRINDER ARRANGED FOR EXTRA LONG WORK

He understands to what degree of accuracy all parts have to be machined, and designs the jigs accordingly.

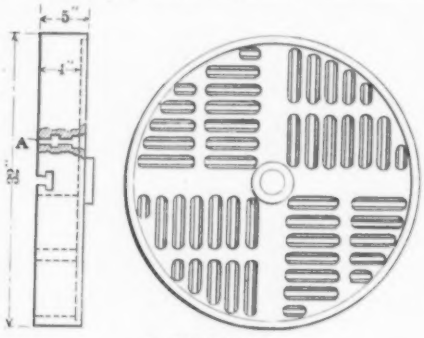
The men in the shop do not look upon him with the suspicion they regard the specialist, who very frequently has not had practical experience in machine and tool work to back him.

JOHN F. WINCHESTER.

Southbridge, Mass.

A Face Plate

The illustration shows a face plate designed by Professor Sweet recently. One of these, 32 inches diameter, was made.



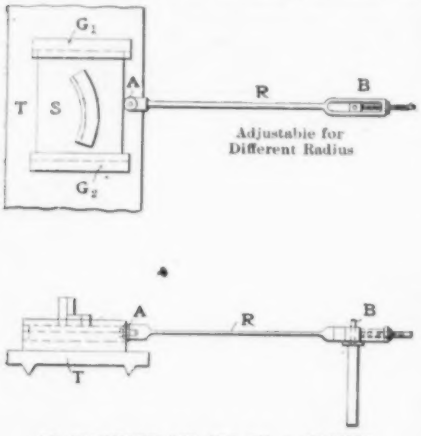
A FACE PLATE

There are four T-slots in the face at 90 degrees to each other. The cored holes in the face plate are arranged as shown and are the shape shown at *A*. It would be difficult to find a piece that could not be bolted to this face plate. With the arrangement of double recessed slots, either short or long T-bolts can be used.

New York, N. Y. E. A. DIXIE.

To Machine an Arc on a Planer

I have read a description at page 487, of an arrangement used to machine arcs on a planer. If I understand that an



TO MACHINE AN ARC ON A PLANER

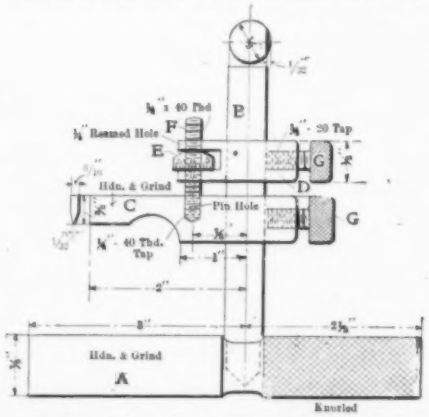
arc is a part of a circle, the described arrangement is not correct, because the line machined by using it can never be a perfect arc. Incidentally, I would say that the line developed is part of a cycloid instead of an arc. To show this, I will write at another time. The following is a short description of an attachment used on a planer to machine arcs.

Referring to the illustration, *T* is the table of the planer, *S* the slide moving in the gibs G_1 and G_2 which are fastened on the planer table. The point *A* of the slide and a vertical shaft *B* are connected by the rod *R*. By this arrangement, when the planer operates, the gibs move with the table and the slide moves in the gibs by the rod *R*. The part to be machined is placed on the slide and the tool is clamped on the planer head. The machined line obtained is an exact arc.

Rochester, N. Y. E. MEITNER.

Hight Gage for Cutter Grinding

This tool is used principally in gaging the hights of the teeth of gear cutters and formed cutters from the center of the cutter and then finding the lowest tooth. After the low tooth has been found, the idea is to grind all the other teeth in the cutter to correspond with the lowest, so that each tool shall do its share of the work. As you will see, I have provided this tool with a micrometer attachment, by



HIGHT GAGE FOR CUTTER GRINDING

which the amount can be read in thousandths of an inch.

We have no special attachment on our grinders for grinding the teeth in a formed cutter so that each tooth will do its share of the cutting, but with the aid of this gage it is possible to grind the cutters properly by hand.

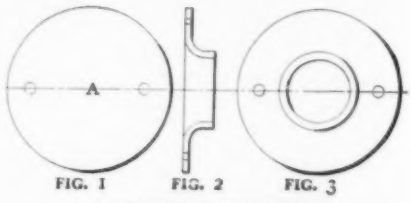
The gage is made entirely of tool steel. Part *A* is nothing more than a plug gage with a hole drilled and tapped to take *B*, which is a piece of steel exactly ½ inch diameter with a flat milled on one side so that the nurled-head screws may always hold the members *C* and *D* in their proper positions relative to *A*, which is hardened and ground to size. Part *C* is hardened and ground at the point of contact only. *C* and *D* can be easily adjusted up or down to suit the diameter of the cutter to be ground. *E* is a graduated nut which fits in a slot in *D*. This nut has a hole threaded ¼ inch by 40 threads per inch and is graduated in 25 divisions, each division equaling 0.001 inch. *F* is a ¼-inch, 40-thread screw, which is pinned at one end in part *C*, as shown, in order to keep it from turning around. *G G* are two screws which secure *C* and *D* to *B* after the gage is set.

This tool has given entire satisfaction and the results from its use cannot be beat.

Brooklyn, N. Y. E. J. RANTSCH.

A Flange Forming Job

The illustrations show a forming job that gave some unexpected trouble. Fig. 1 shows the blank to be formed and Figs. 2 and 3 the finished piece. The trouble



A FLANGE FORMING JOB

experienced was that the edges of the hole showed an irrepressible tendency to break out under the forming punch.

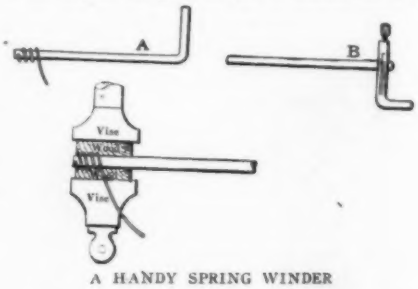
The stock was dead soft and should have formed easily. Annealing was tried after blanking, without success. It was finally suggested that the hole *a* be drilled instead of punched. This was tried and we found we could use a drilled hole 3/16 inch diameter with good results, while a punched hole ¼ inch diameter would break out every time. The metal around the punched hole seemed to be crystallized.

Kalamazoo, Mich. P. A. FREDERIC.

A Handy Spring Winder

I have noticed from tim to time items about making compression coil (or helical) springs, but have not seen the simplest way to do it described. More than 25 years ago I made springs in this way:

I took a piece of rod a trifle smaller then the inside of spring was to be, bent it in crank shape, sawed a notch in the



A HANDY SPRING WINDER

end wide enough to admit the wire; took a block of wood 2 or 3 inches wide through which a hole was bored the size of the rod—and the rig was done as shown in the sketch.

To space the coil a piece of wire the diameter of the space wanted was bent

mto a hook and as the crank was turned this hook was slipped over the mandrel and compelled the coils to take the correct pitch. The sketch shows the hook with a string at the lower end. This had a loop at the lower end for the operator's foot, to hold it in place.

Occasionally the mandrel would be so small that I could not cut a notch in the end. In that case I held the wire with a small hand vise. This could of course be done in all cases but the vise is not as convenient as the slot.

League Island, Penn. P. DEVAUX.

The Limit of Proportionality and the Elastic Limit

Mr. Hess' letter, on page 489, explaining his statement that "a limit of proportionality above the elastic limit is desirable," is interesting in showing how different writers sometimes use the same term with widely different meanings. Most writers define the elastic limit as being the same as the limit of proportionality. For example, on page 236 of the "Mechanical Engineer's Pocket Book," is the following:

"The elastic limit is defined as that point at which the deformations cease to be proportional to the stresses, or the point at which the rate of stretch (or other deformation) begins to increase. It is also defined as the point at which the first permanent set becomes visible. The last definition is not considered as good as the first, as it is found that with some materials a set occurs with any load, no matter how small, and that with others a set which might be called permanent vanishes with lapse of time, and as it is impossible to get the point of first set without removing the whole load after each increase of load, which is frequently inconvenient."

"Professor Bauschinger defines the elastic limit as the point at which stress ceases to be sensibly proportional to the deformation, the latter being measured with a mirror apparatus reading to one five-thousandths of a millimeter. This limit is always below the yield point and may on occasion be zero." The yield point is defined as that point at which the rate of stretch suddenly increases rapidly. It is recognized in practical testing as that point at which the beam of the testing machine first drops after being balanced with an applied load, the machine running very slowly, as the point at which the first visible stretch of one-fiftieth of an inch or more appears on an 8-inch specimen of soft steel when the stretch is measured with a pair of dividers, and as the point at which the scale begins to crack off a rolled bar.

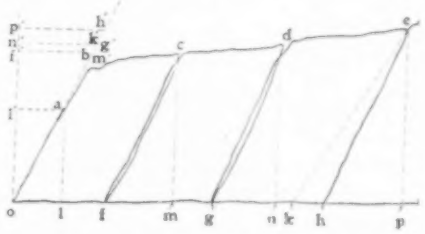
The French commission of 1895 adopted three critical points of a test diagram (see Johnson's "Materials of Construction," page 306) namely:

1. The elastic limit, or the unit stress beyond which a portion of the deformation remains as a permanent set.

2. The proportional elastic limit (la limite d'elasticité proportionelle), corresponding to the point where the deformation ceases to be proportional to the loads.

3. The apparent elastic limit, corresponding to the point where the deformations increase rapidly without any increase in the force exerted.

Professor Stribeck, however, as quoted by Mr. Hess, defines the limit of proportionality as something entirely different. He says: "Beyond the elastic limit there occur permanent as well as elastic deformations, the two together giving the total deformation. . . . While the line of the total deformations is curved beyond the elastic limit, the line of the elastic deformations is a directly proportional continuation beyond the elastic limit; in other words, there is direct proportionality between the elastic deformations and the stresses also beyond the elastic limit. The limit of proportionality lies at the point at which the elastic deformation line begins to curve. With hardened steel, the



TENSION TEST DIAGRAM OF A PIECE OF STEEL

proportional limit for the elastic deformation is much higher than the elastic limit."

Professor Stribeck's limit of proportionality is therefore that point at which the elastic deformations, that is, total deformations minus permanent sets, cease to be proportional to the stresses, while the term as ordinarily defined is that point at which the total deformations begin to increase at a faster rate than the stresses, or in other words it is the true elastic limit as distinguished from the yield point.

Let us consider a plotted tension test diagram of a piece of steel, Fig. 1, in which the vertical distances represent stresses and the horizontal distances elongations. The line *o a* is a straight line, except a trifling deviation at the beginning due to internal strain, errors of measurement, or bending of the specimen caused by defect in the testing apparatus. If the load is gradually released, the line *a o* will be re-traced to the origin, and *o l* is the elongation when the bar is loaded to *a*. This is entirely an elastic deformation. Continuing the test beyond *a*, the yield point is reached at *b*, and the bar suddenly stretches without increase of load. Somewhere between *a* and *b* is the elastic limit, or limit of proportionality. Its exact location is difficult to determine. If a microscope or mirror apparatus is used, it may be found near *a*, but with an extension for reading to one ten-thousandths of an inch, it will be a short distance below *b*. Let the test be continued to *c* and the load gradually released and then applied again. The down and up lines plotted from the stresses and elongation will be almost exactly parallel to *o a*, but will form a very narrow loop if the magnification is large enough, the width of the loop being only a few ten-thousandths of an inch. The width of the loop is apparently a function of the time taken in releasing and in re-applying the load, as it diminishes nearly to zero if sufficient time is allowed.

The distance *o m* is the total deformation corresponding to the stress at *c*, *f m* is the elastic deformation and *o f* is the permanent set. Continuing the test in like manner to *d* and *e*, with release of load after each, we obtain the total elongations *o n* and *o p*, elastic deformations *d n* and *h p*, and the permanent sets *o g* and *o h*. The elastic lines *c f*, *d g*, and *e h* are parallel to *o a*, making the four triangles similar, and the elastic deformations *o l*, *f m*, *g n* and *h p* are proportional to the stresses *l a*, *m c*, *n d*, and *p e*. The modulus of elasticity, defined as the quotient of the load per square inch divided by the elastic elongation per unit of length, and calculated each from the new zero of load is a constant, about 29,500,000 for all rolled carbon steels. The limit of proportionality of elastic deformation is always far beyond the elastic limit for safe steels, and the statement quoted by Mr. Hess that "A limit of proportionality above the elastic limit is desirable" is mere surplusage, for such a limit is inevitable.

Let us suppose, however, that on reaching the stress *e* and releasing it, the line traced downward is not parallel to the other inclined limits, but has a lower inclination as *e k*, indicating a lower modulus of elasticity. The elastic deformation will be greater, *k p*, and the permanent set will be less, *o k*. We will then have reached Professor Stribeck's so called limit of proportionality, the point at which the elastic deformations cease to be proportional to the stresses, or as he says the elastic deformation line (on his diagram, Fig. 2, page 489, *o a g' k'* in the figure here given) begins to curve. I doubt if such a curve is ever found until the specimen begins to "neck down" before breaking, or its diameter is appreciably reduced, or until the bar begins to break in detail. All of this discussion of Professor Stribeck's limit of proportionality, however, is of little practical value, and is really "academic." Tests are not made in practice by releasing loads and measuring permanent sets

and elastic deformations beyond the elastic limit. There is no need of the term limit of proportionality except as a means of defining the true elastic limit, to distinguish it from what is commonly still called the elastic limit, that is, the yield point; and the application of the term as Professor Stribeck defines it should be allowed to fall into "innocuous desuetude."

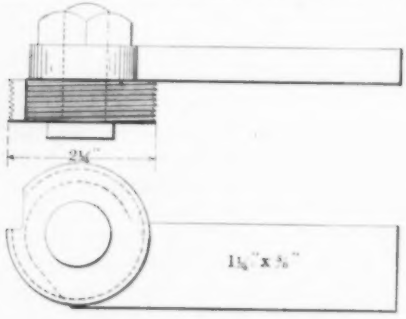
Syracuse, N. Y. WM. KENT.

Cutting Screw Threads

The article on cutting screws, by C. A. Marston, published on page 491, describes a method which is, as he admits, old, yet no doubt will be of interest to all those who have anything to do with thread cutting. About two years ago you described a method which was perhaps an improvement on this, for in it we were directed to set the compound rest at 29½ instead of 30 degrees. Thus as the tool fed in, there was still the half degree left as a slight scraping cut, which made a nice finish when the tool was deep enough, without having to use a slide as described by Mr. Marston.

Just why this method is not better known and more often used by lathe hands has always been a surprise to me. When cutting threads, I make it a practice not only to use a compound rest as described, but always to have two tools, one for the roughing cut and another to finish with. I think we can all remember having ground up a nice threading tool to a keen, sharp edge in the beginning of our work, which of course was dull before the thread was half finished and had to be taken out and reground. It is far better to have a roughing tool with a round point that does not easily dull than to put in a well sharpened finishing tool just to clean up the thread.

The old-fashioned chasers are but little used in these days; the greatest objection to them is perhaps their cost. A



CIRCULAR THREAD CHASING TOOL

splendid substitute and a durable, cheap tool can be made in the form of a circular cutter chased in the lathe in the regular way and clamped on a tool holder as shown in the sketch. It will be seen that these tools will stand a great deal of grinding; they are easy to make and for ordinary work are quicker and better than anything else that I know of. In a shop where there is much threading to do, the tool room should be well supplied with these chasers; where men work piecework, they will be found in great demand. The tool holder will do for a great many cutters, for by loosening the bolt, cutters of any pitch can be clamped in place.

Toronto, Can. J. T. WILFRED.

Grinding Slotting-machine Tools for Heavy Cutting

The usual type of slotter tool, as used in bars for heavy work, is shown in Fig. 1. This tool, although exclusively used in this country, is to my mind decidedly wrong; for instance, the cutting edge first comes in contact with the work at the extreme point marked *A*. As this is the weakest point of the tool, it makes

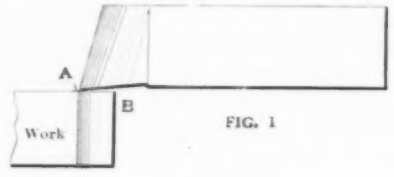


FIG. 1

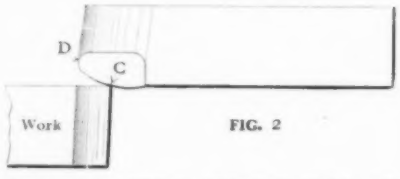


FIG. 2

GRINDING SLOTTING MACHINE TOOLS FOR HEAVY CUTTING

it very liable to break when it strikes the work it is operating on, and also upon the return stroke, even if the bar is provided with a frictionless return. The point of the tool strikes the work at the extreme full depth of cut first, which is some distance from the outside edge *B*. This puts on additional stress, due to the fact that the point has to force or punch its way through the solid material. The stronger or back part of the cutting edge comes into contact when the point has separated the chips; therefore its work is very much lighter, although it is the strongest part of the tool. I think most readers of the AMERICAN MACHINIST will agree that this is one of the "things that are generally wrong."

The tool shown in Fig. 2 is free from the above mentioned drawbacks and will stand much more severe work without showing any sign of weakness. It takes less power to drive it for the same depth of cut than Fig. 1 takes; instead of the weakest part of the tool striking the work first, it comes in contact at the point marked *C*, which is the strongest part of the cutting edge, and, striking the work on the outside edge, gradually chips or shaves its way along until it comes to the extremity *D*, which is the highest point. The strongest part of the tool *C* having commenced to separate the chips, the point *D* has not such severe duty to perform. Further, not having a pointed end, as at *A*, there is not so much danger of breaking it off. I have seen this tool used on heavy steel crank forgings, taking a roughing cut off 1½ inches deep, with a feed of 40 per inch. The tool, 4x11/16-inch section, stands up to its work perfectly and is a revelation to those accustomed to using the one shown at Fig. 1.

England. SYDNEY LAWRENCE.

Boring Bars and Cutters

Referring to the article on page 452, in regard to boring bars and cutters, I would like to add a suggestion which has proved satisfactory with me. In the cut you have shown the cutters as in Fig. 1. Parts marked *B* are the cutting edges. These parts are ground when dull, until *B* is worn to the surface which I have marked *C*. As the part marked *B* is used to register, the cutter is now worn off, and is worthless. In cutters that we make, the cutting edge is the part marked *D*. We put the wedge key in front, as in Fig. 2, and our cutters last longer, but are made the same way.

Another kink I have to offer is a difficulty which was overcome the other day in our tool room by one of the men. We are building a special machine where there is considerable boring to do. In one place we have four bearings which must line with each other. A shaft ⅞ inch in diam-

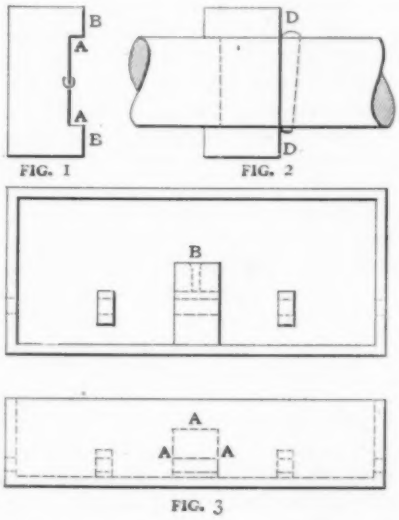


FIG. 1 FIG. 2

FIG. 3

BORING BARS AND A BORING JOB

eter fits in them. The two outside bearings are about 38 inches apart; to bore all four bearings we found that we had to use such a long bar of so small diameter that it sprung, so that we were in difficulties right away. There was no finished part of the casting to which to fasten a temporary bearing for the boring bar, so

this is the way it was done. First the bar was trued up so as to run perfectly true in the center. Four tools were put in, one to cut each bearing. The piece to be bored was set up in the boring mill with the bar in position ready to bore. A piece of hard wood was bored out 1½ inches and fastened in place with the boring bar through the 1½-inch hole. Babbitt was then poured in the hole around the bar. We then had a center bearing for the boring bar which prevented any springing, and we finished the piece with all four bearings in line.

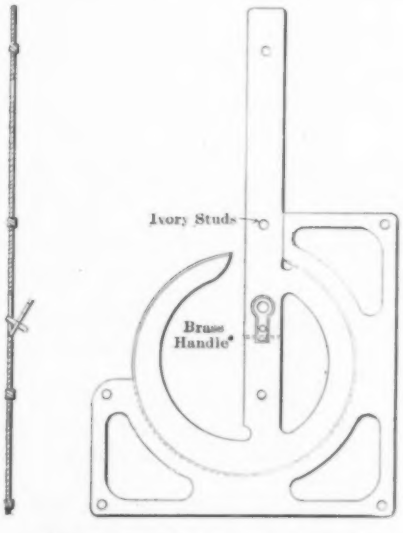
Fig. 3 shows the four bearings in line with the temporary bearing in the center. The piece marked *A* indicates the temporary bearing, and *B* indicates where the babbitt was pored.

Bridgeport, Conn. J. W. OGDEN.

A Draftsmen's Protractor Kink

The illustration shows another improvement on a Brown & Sharpe draftsmen's protractor. About three years ago I bought such a protractor. The first time I wanted to use it, I set it to the required angle and laid it down on the drawing; then it required some shifting to get it in the right position, and when I finally picked it up again the drawing was dirty.

To improve it I drilled several holes and tapped them out No. 8-32. Then I prepared a stick of ivory and screwed it into the holes, cutting it off so that it projects 1/32 inch on each side. I cut



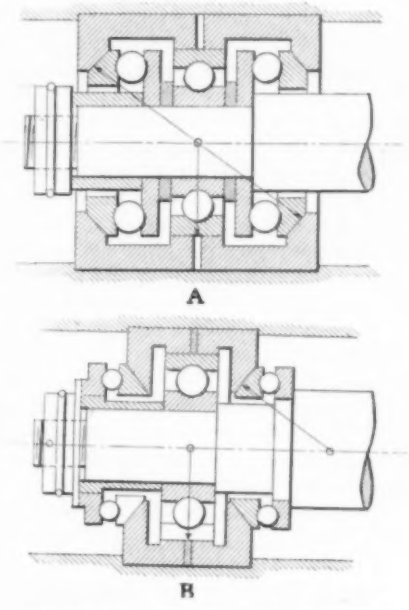
A DRAFTSMAN'S PROTRACTOR KINK

a hole for the handle, which swings on a pin as shown. In the enlarged part of the handle I drilled a hole, by which to hold it with the finger tips. I also put an ivory stud in the handle, letting it project 3/16 inch on each side, so that the handle is always raised when the protractor is laid down on either side, as shown at the left. Now I can lift the protractor by the handle and put it down in any position and the paper is not soiled.

Orange, N. J. O. F. PAUL SPITZEL.

Design and Use of Ball Bearings

I was surprised to see advocated, at page 337, in your abstract of Mr. Hess' paper before the American Society of Mechanical Engineers, a method of housing ball bearings, which is not considered



DESIGN AND USE OF BALL BEARINGS

good practice on this side. I refer to the method of housing shown in Fig. 44, and in part to that in Figs. 41, 42 and 43.

Mr. Hess rightly lays great stress on the need for a proper application of ball bearings, if the full advantage is wished for. This is the experience of all those who have had to study the application of ball bearings to such purposes as automobile construction. I was therefore the more surprised that Mr. Hess should advocate any system but the best.

In Mr. Hess' Fig. 44, which I have reproduced as *B*, it will be noted that the three surfaces which are required to slide in case of any rocking motion, or want of linability of shaft and housing, due to any cause such as bending of the shaft under its load, are surfaces approximately tangential to imaginary spherical surfaces round three distinct centers. It seems to me that with this construction the whole benefit of the spherical or approximately spherical faces is lost, as the slightest departure from linability will at once put on the balls an extra crushing strain over and above that due to the load. No further proof of this is required but to remember that when the shaft moves, it can only move round one center, whereas by this construction there are three centers.

The practice over here would be to mount the bearings as shown at *A*, by which it will be seen that the sliding faces are tangential to two concentric imaginary spheres, which allows the bearings to rock around their common center with the minimum of added strain on the balls.

The same remarks apply in part, as I said before, to the construction shown in Figs. 41, 42 and 43, as will be evident by inspection of the figures.

VALENTINE GEORGE BARFORD.

England.

Locking Nuts for Boring Bars

As an addition to the many boring-bar ideas, I wish to suggest a scheme which was used to prevent boring bars, cutter holders, etc., from jarring out. In this case the arrangement was used on a lathe and a drill press, the taper holes of which were made duplicates and the nose of the drill spindle threaded the same as that of the lathe, making the fixture interchangeable.

Fig. 1 shows the bar with a slight shoulder. A special nut which fits the spindle nose, when screwed in place, draws against this shoulder and keeps the bar in place.

Fig. 2 goes farther in also providing means to draw the bar out; moreover,

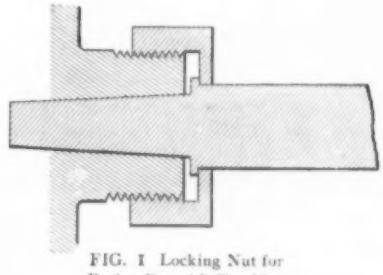


FIG. 1 Locking Nut for Boring Bar with Shoulder.

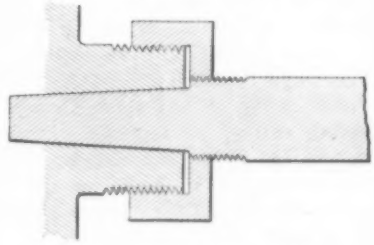


FIG. 2 Differential Locking Nut

LOCKING NUTS FOR BORING BARS

having no shoulder, it allows the bar to be made from smaller stock than Fig. 1. Fig. 2 bar should be threaded twice as many per inch as the spindle; the length of the threaded portion should be such that the nut can travel about ⅛ inch plus one-half the depth of the large-threaded part of the nut. In placing or removing, the bar is held from turning. When re-

moving, by the time the nut is to the end of its thread on the spindle, it is also about to the limit on the bar, and the taper is well out of its socket. In a shop where pipe wrenches are handy, the outside of this nut can be left rough as in the bar; a pipe wrench then operates it as readily as a monkey wrench would an ordinary nut, and some expense in work is saved; also the diameter can be kept small when that is a benefit.

Fig. 1 may have a short threaded part between the large end of the taper and the shoulder, with a nut of diameter slightly smaller than the diameter of the spindle nose; this would draw the bar out. The large outside nut must then be longer, so as to reach over both the shoulder and the throw-out nut. All threads should be right-hand.

Philadelphia, Penn. E. J. Bowers.

How to Find the Angle for Flanging Tank Sheets

In one corner of my note-book I have a small sketch similar to the accompanying diagram, and I frequently find it a convenience in finding the angle to which to bend the flanges of tanks and hoppers. Anyone not familiar with laying out such

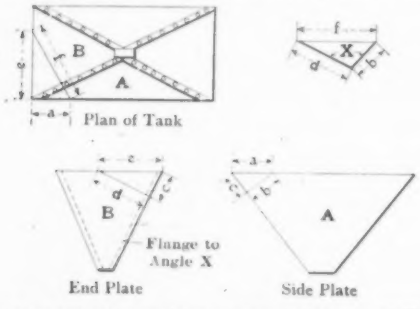


DIAGRAM TO DETERMINE THE ANGLE OF THE FLANGE OF TANK SHEETS

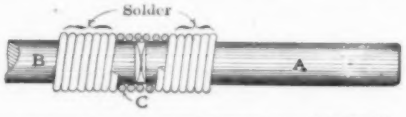
work, it may save from becoming tangled in revolving planes. The diagram shows the plan of a tank and details of the plates *A* and *B*, with the edge of plate *B* flanged and riveted to plate *A*. The object is to find the angle to which to bend the flange. On plate *A* lay off any short distance *a* from one end of the top side. Draw *b* from the end of *a* perpendicular to the opposite side, and so determine the distance *c*. Now lay off the distance *c* on the edge of plate *B* and, by drawing *d* perpendicular to the edge, we determine the distance *e* on the top side of plate *B*. Then lay off *a* and *e* on the plan, as shown, on plates *A* and *B* respectively, and draw *f* connecting the ends of *a* and *e*.

The final step is to determine the angle *X* by laying off a triangle with the three distances *f*, *b* and *d* as the three sides. The angle *X* between the sides *b* and *d* is the angle to which the flange on plate *B* should be bent.

Urbana, Ill. F. B.

Flexible Drive for Small Drill or Boring Bar

It is sometimes desirable, when using a drill or boring bar, in cases where the bar is used in connection with guide bushings in a fixture, to provide a flexible drive in order to avoid any tendency to cramp the



FLEXIBLE DRIVE FOR BORING BAR, OR DRILL

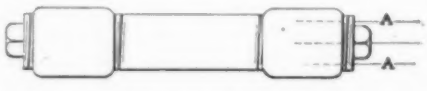
bar. The accompanying sketch shows a simple and inexpensive form of universal joint which has been used successfully by the writer for driving small boring bars and drills, in cases where the fixture bushings have been more or less out of line with the driving spindle. It consists of the boring bar or drill *B* and the short shank *A*, the ends of each being slightly convex, as shown. The spring *C* is wound close, slipped over the joint and soldered at each end. The spring should be wound so as to fit the cores, and in such direction as to cause it to have a tendency to close tighter on the cores from the resistance of the cut. The ends of the bar and shank being convex, the flexibility of the spring will readily permit of considerable deflection in the alinement of the bar and driving spindle.

Pittsfield, Mass. H. D. Penney.

Another Way of Annealing High-speed Steel

In Vol. 30, page 493, is an article under the heading "Annealing High-speed Steel," in which several methods are given for doing the work. As none is like the method which I employ, I will describe mine.

The steel to be annealed was "Capital" and was of approximately the following dimensions, ½x1x8 inches. I first procured a piece of wrought-iron pipe about 2½ inches diameter by 12 inches long and screwed a coupling on each end. Then I screwed a plug in one of the couplings.



ANNEALING CANNON

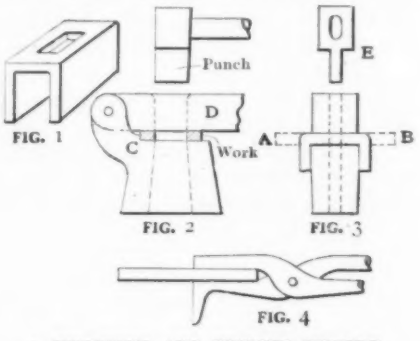
I then put about 2 inches of molding loam in the bottom of my improvised cannon. Next, the steel to be annealed was put in the center, then more loam was packed around it and rammed into the cannon so that it was packed tight. I then screwed on the other screw plug, in which several 1/16-inch holes had been drilled for test wires, as shown at *A*, with which to test the heat, as we did not have any thermometers. The cannon was then placed in the forge and the steel was brought up to a cherry red, at which heat it was kept for about an hour and a half. The cannon was then removed and placed in a bed of live charcoal which had been placed in the ash box, all of which was then covered with ashes and allowed to cool slowly. Upon removing the steel when cool, it was found to be as soft as any tool steel.

I have tried annealing steel of this kind without packing it, but must say that I had very little success and attributed it to the blast which was necessary for the operating of the forge, which was a charcoal forge with a compressed-air blower operated at a pressure of 15 pounds per square inch.

Waterbury, Conn. W. L. Moder.

A Punching and Bending Fixture

Figs. 2, 3 and 4 show a fixture for punching and bending. Fig. 1 shows the work finished, Figs. 2 and 3 the fixture itself with the work on the anvil. The piece to be operated on is taken from the fire in the tongs Fig. 4 which centers the



A PUNCHING AND BENDING FIXTURE

work lengthwise on the anvil, and placed against the shoulder *C*, which squares the work. The lever *D* is then brought down on the work and the punch driven through, the hole in *D* acting as a guide. The ends *A* and *B* are then turned down. The shoulder *E* on the punch is left sharp to act as a stop and, in case the punch sticks, to pry it out.

In looking at this work, it would appear that the proper method for doing it would be to punch the hole cold and then heat and bend; but as this work can be done in one heat, in less than two minutes' time and with a cast-iron die having a cored hole, you will readily appreciate that there is a considerable saving of time by this method. It was the original intention to do this work with this fixture under a power hammer; but when it was found that three blows of a light sledge would put the hole through, it was decided to mount the fixture on a swedge block and leave the power hammer free for the other work.

Jersey City, N. J. Herman Jonson.

Standard Shapes of Tools

In reading the articles by F. W. Taylor, on "Standard Shapes of Forging and Grinding of Tools," I admire their tone, which is very instructive, but differ on many points. I believe that metal-cutting tools can be made in a simpler way without so many expensive fixtures in forming and forging the tools to shapes ready for the emery wheel to be shaped. An artisan running any iron-working tool successfully should be able to judge what shapes are best adapted for his special purpose, and it cannot be expected that a blacksmith should know the machinist's requirements.

Standard shapes can only be adopted in form and size best suited to their various duties, and few shapes are necessary. They cover the roughing, side, square, parting, thread, straight, right and left, as also various shapes of boring tools. I can hardly comprehend that the development of the standard shape advocated for cutting tools represents 25 years' experience, including over 30,000 experiments at a cost of between $150,000 and $200,000. It seems hardly possible that it took so many thousand experiments and such a handsome fortune for such a simple matter as common tools.

In forging the tools ready for the grinder to shape them, I would have to differ seriously with Mr. Taylor's plan as to using such methods as B and C, K and I, and L, pages 655 and 657. These are very costly and I think unnecessary. Mr. Taylor is making tool forging quite an art, while I consider it simply a common proposition. I can forge at one heat a tool letter A, ready to be ground, of 1x⅝-inch stock as perfect as you may wish, without any expensive tools such as illustrated.

I cannot recognize Mr. Taylor's standard shapes as being new, for I have seen those shapes used nearly 40 years, and have forged them as many years. I have forged, ground and tempered ready for the lathe one dozen roughing tools made of 1x⅝-inch stock, right off of the bar, very similar to the shapes shown, in 1¾ hours.

I notice that Mr. Taylor requires five heats to finish one round-nose roughing tool, which I make in one heat without any trouble for ordinary-size stock, using no dies nor forms of any kind, only the necessary tools as used by any good blacksmith. I suppose that the many forms and dies used make up the expense indicated.

The symbolizing of tools I heartily agree with; it should be done in any well regulated manufactured concern where order is to be maintained.

In reference to grinding the tools to finished shape, I consider the grinder shown a substantial, simple and well designed tool. I am not fortunate enough to possess such a machine to grind my tools; I do my work with a simple emery wheel, and it is a good one for general work. I grind as many as 40 tools, after being rough forged to shape, ready to temper in almost as many minutes; and I assure the readers that they are very nearly right for cutting purposes. After grinding to shapes, I temper the tools carefully, and they will stand the hardest usage.

HERMAN FLETCHER.

Louisville, Ky.

The Over-all Dimension

The draftsman made a blunder,
But it wasn't very bad,
He simply failed to figure right
The thickness of a pad.

But when he finds his error,
And the patternmaker calls,
He makes him take his pads off
And change his "over-alls."

McREEL.

Repairing Micrometers

Quite a number of the correspondents of the AMERICAN MACHINIST have had their say about repairing micrometers—some how to repair them, and others how not to. But why have them wear out of pitch? If made with screw and nut of equal length, say 1½ inches for a 1-inch size and so located that the screw will be about ⅛ inch out of the nut when the feelers are in contact, it will endure a life time without losing its pitch as much as a common one will in a year. By using a buttress thread, the slack can be taken up without any material change in the anvil when closing the nut by a couple of grip screws. Why is it that it takes designers so long to learn that two surfaces properly proportioned (and in this case properly proportioned means of equal length) do not wear out of true, and do not wear fast anyway?

If the machinist has one too badly worn to use, he had better take the advice of your latest contributor and send it to the makers for repairs. If they charge him twice what he thinks they ought, it is likely to be better than he can do for himself, as a lathe that will cut a true pitch screw is a rarity.

It is easy to understand why one who is making a machine or tool, who is fixed up for it, who is making and selling lots and making money, should keep right at it; but why the other fellow who starts anew, going in opposition, handicapped by the other's lead and reputation, should not study the defects of the original and overcome them, is not so easily understood. In this case the history of the measuring machine tells the whole story.

Syracuse, N. Y. JOHN E. SWEET.

Inefficient Machine-shop Lighting

In the editorial on this subject is certainly described the usual condition of factory lighting when it is stated that the scheme for general lighting is much better than that for individual-machine lighting. Though electric lights in shops have been common for more than a decade, the light on the machine in more than 99 cases out of 100 has the appearance of having been left there by accident; the workmen are allowed to use it if they find it convenient. The most surprising thing in this connection is that most workmen are content to let the light hang so as to throw shadows where light is wanted, and light where shade is wanted, namely, in their eyes. An arrangement which I tried some years ago was so cheap and efficient that I will offer it to the readers of the AMERICAN MACHINIST.

It was simply a piece of insulated copper wire, about 4 feet long and heavy enough to bear the weight of an incandescent lamp and its accompanying cord. This particular lamp was used on a 16-inch lathe. One end of the copper wire was stripped of its insulation and inserted in a hole, made for that purpose, in the oil-can stand attached to the tailstock. The lamp cord was loosely tied to this wire about a foot above the tailstock, and at two more places between that point and the other end where the lamp was made fast in a semi-rigid position. There was no pendant lamp in this case. Though this heavy wire was strong enough to bear the weight of the lamp, it was flexible enough to be bent readily by one hand. During most of the time the wire stood in the form of an inverted U; but if the lamp was needed in any other position, the wire was readily bent to that position, and there the lamp would remain until the wire was bent again. With the combined shade and reflector which accompanied this lamp the best of results was obtained. In this particular case one piece of wire was in use for over two years and may still be in use on the same machine for all I know. For a larger machine it is obvious that the lamp should be attached to the carriage and not to the tailstock. The above is not put forth as a substitute for something better; it is merely pointing out how easily a very efficient flexible arm may be made.

Chicago, Ill. W. S. R.

A recent test by the Canadian commissioners who are investigating the cause of the collapse of the Quebec bridge was conducted on a steel eye-bar similar to those used in the structure of the bridge. With 28 square inches of surface the strain was 63,000 pounds to the square inch, so that the quality of the steel used seems to be above reproach.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

During 1906 *the* AMERICAN MACHINIST *printed and circulated* 1,083,205 *copies, an average of* 20,832 *per issue. Of this issue* 19,000 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

Contents

PAGE

A Precision Drilling and Reaming Machine 963
New British Gear Hobbing Machine.... 967
Power Transmission by Friction Driving 969
An English Universal Grinding Machine 974
Question in Engineering Ethics..... 979
Locating Holes Accurately in Special Tools 980
Organization and System for a Tool-drawing Room 981
Practical Letters from Our Readers: Grinding a 22-foot Shaft On a 12-foot Machine....The Tool Designer's Troubles....A Face Plate ....To Machine An Arc on a Planer ....Hight Gage for Cutter Grinding....Flange Forming Job.... Handy Spring Winder....Limit of Proportionality and the Elastic Limit....Cutting Screw Threads ....Grinding Slotting Machine Tools ....Boring Bars and Cutters.... Protractor Kink....Design and Use of Ball Bearings....Locking Nuts for Boring Bars....How to Find the Angle for Flanging Tank Sheets ....Flexible Drive for Small Drill ....Annealing High-speed Steel.... Punching and Bending Fixture.... Standard Shapes of Tools....Repairing Micrometers....Inefficient Machine-shop Lighting.....983-989
Interest and Enthusiasm in the Shop.. 990
The Passing of the One Shop Plan in Machine-shop Organization..... 990
New Tools and Machine-shop Appliances 992

Interest and Enthusiasm in the Shop

Few will deny the value of enthusiasm in any undertaking; this holds just as true in the machine shop as elsewhere. The problem of securing it and of maintaining it is not an easy one, and is well worth the careful consideration of every shop manager.

The forerunner of enthusiasm is always interest; secure the interest of the men in various departments and you are on the road to enthusiasm; in fact it is rather a hard line to draw between the two. Hold the interest and you can let enthusiasm take care of itself.

There are many shops, however, where this is entirely overlooked, some going even so far as entirely to discourage any interest on the part of the men so that it is little wonder that "six o'clock and pay day" come to be the only objects of real interest in too many cases. And the shop managers have only themselves to blame.

Some shops prevent any information regarding the work in hand from getting into the shop, and men work day after day on bolts, rods, straps and other parts without knowing whether they are for a new engine or a new gunboat or going in a little shop around the corner. In any case every machinist would be much more interested in his work if he knew where it was going. Even commonplace bolts and nuts take on a new interest if they are going into some new machinery, or to some unusual place.

Can you imagine anything more disheartening to a live man than to have all his efforts at becoming interested in the work thwarted by a wall of silence or refusal to give any information regarding it? If you asked what certain pieces you were making were for and were told in more or less polite language that it was none of your business, would your interest in the welfare of the shop or your loyalty to it increase to any great extent? Or can you not appreciate the feeling of disgust and resentment that a man feels who has worked all night on a rush job, perhaps given up an evening which had been planned for far ahead and disappointed others as well as himself, to find that it is not shipped out for a week and no explanation given? There may be a good reason for it all, but if he doesn't know it, he has every right to all the feelings that crop up. And they do not make him any more valuable to his employer.

Any system of shop management which ignores the human factor has a decidedly weak spot in its make-up, for without it you cannot get the interest that increases quantity and quality of output to the utmost. Even if you make of a man nothing but a machine, giving him certain tools, making him use them a certain way and in every way discouraging individuality of thought, you can still rouse a little interest by keeping him informed as to work he is doing and to the general trend of the shop. If he is to assist by his loyalty and coöperation, he must know as much as possible of the details of the work he is on. You cannot expect the fullest coöperaiton when his attempts at becoming informed are blocked by the cold none-of-your-business spirit.

Some shops are taking advantage of the personal element to the extent of issuing bulletins which, instead of preaching loyalty and enthusiasm—like guide boards that point the way but never go themselves—arouse both by telling the men all that is of interest about the work in hand. If it is possible to tell where it is to go, and it generally is, they do so. If there are 10,000 bolts of one size, they note the fact and tell what this means in weight of metal, both rough and finished. Even the boy on the bolt cutters likes to be helping on the big job, and he will take more pride in doing them well than if no interest were shown in telling him about them.

The question of interest is not one-sided, and it is not reasonable to expect it from the men when they have nothing to be interested in. Take them into your confidence so far as possible, and you will find a keener interest in the work on all sides. This is one of the secrets of success in the small shop where the "old man" told you all about the work if you asked him, sometimes when you didn't, and where you couldn't help being interested if you wanted to. Human nature hasn't changed since the days you were in the shop, and interest will develop if you give it a chance.

The Passing of the One-shop Plan in Machine-shop Organization

The development of the jobbing machine shop or general machine shop into the manufacturing plant brought into common use a method of organization commonly known as the one-shop plan. This might be better characterized as a machine-department plan, as the machine tools of the same kind were grouped in individual departments and all of the work passed through them in rotation as the various operations required. It was a natural development and paralleled the organization of other industries, among which might be cited the textile. During the last few years, however, several plants which have reorganized their production departments have abandoned the one-shop plan and have instituted classifications, either according to the kind of work or what might be called the job-department plan, or according to the finished product, which might be styled the output-department plan.

From an equipment standpoint the machine-department plan is undoubtedly the most efficient. All machine tools of a given kind, with their attendant attachments, jigs, fixtures and small tools, are concentrated. The executive force, general foreman and second hands, need be expert only on one line of machines; similarly the workmen need be experienced on only one operation, as all the work of the plant requiring that operation is sent to this one place. It allows the foreman to select his work to the greatest advantage, considering particular machines and particular workmen. This permits of a maximum production with a minimum number of machines and theoretically presents a most efficient organization.

Yet, as successful production is largely dependent upon good foremanship, and as such departments through concentration are apt to be large, the executive force is greatly taxed. As only one operation or a few similar operations on a particular piece are done in that department, and as the men in that department are only skilled in that kind of operation, it follows that the connection between preceding and succeeding operations and the one which is being done is lost sight of. The department is interested only in its own particular work, which may be a very limited portion of that which is required to produce a single part. As a given piece must pass from one department to another through succeeding operations, it must come in contact with a large number of department executives and cover an enormous amount of factory floor space, from the time it starts as raw material until it reaches the inspection room as a finished product.

This fact has led to the development of card indexes, tracing systems, mechanical memories and many other devices in order to keep track of work in process and control its progress through all of the various departments, in order that it may be available when wanted to fill customers' orders. With this type of organization it is also difficult to uphold the quality and accuracy of the work, for the viewpoint of the men concerned in the details of manufacture is that of a single operation, or allied operations, rather than of the part as a finished whole. These two factors are the principal difficulties with the machine-department plan: the control of work in process and the upholding of its quality. The first is sometimes partially overcome by carrying a large amount of finished stock; but this is objectionable as it ties up working capital, because the parts may become obsolete in design and finally have only a junk value, because of interest losses if they are kept for long periods of time and as fluctuations in the prices of labor and raw materials may produce a situation in which they could be produced at the time of sale for much less than their actual cost. These difficulties increase in a rapidly increasing ratio with the size of the department and the excellence of the quality of the work demanded, and have led to two other systems of organization.

The job-department plan concentrates work of a similar character in the same department. For illustration, one department might make shafts, spindles and rods and have an equipment of machine tools and small tools for completely producing those parts from the raw material to the finished product. Another department might produce cams, gears and pulleys under parallel conditions. The amount of equipment to carry on a given volume of work with this system is undoubtedly greater than under the machine-department plan, yet it has the advantage of restricting to a minimum the floor area over which a given piece must be transported during the process of manufacture and fixes the responsibility for the accuracy of the work upon a limited number of men. It also retains the expert character of its executive, though in a different manner; for now he must have experience on a given line of work, where before he had experience with a given line of machine tools and operations. It lacks, however, the element of unification in producing a finished machine. Here, as in the machine-department plan, individual pieces must be gathered from the entire factory area before a machine can be erected. Thus as many executives will have to be consulted and will have to contribute their share of parts before promises of shipment can be made and lived up to.

A recognition of this difficulty brings us to the third method of organization, which we have characterized the output-department plan. This differs from the job-department plan in that the product of the department, instead of being individual pieces of allied kinds, is a finished article or machine ready for shipment. It is probable that as regards equipment this is the least efficient of all. The expert character of foremanship is now along lines of finished product and demands an intimate knowledge of all classes of machine tools and machine-shop operations. The element of responsibility for the quality of individual pieces is as well cared for as in the job-department plan. The excellence of the finished product is better cared for because the responsibility for all of the parts, as well as the assembling, is with one factory head. The responsibility for promises of delivery dates and of meeting those promises is with an individual, rather than with the entire factory organization. Thus the works manager can approach a given production problem much more directly and quickly, and production is the ultimate end of every manufacturing organization. In one large machine shop a change of organization from the machine-department plan to the output-department plan reduced the number of foremen necessary to contribute to a certain manufactured line by 75 per cent.

We are justified in looking upon this development as an evolution of the manufacturing machine shop from the general machine shop, with its steps tending toward greater efficiency.

Personal*

C. E. DeCrow, formerly with the General Electric Company, Chicago, Ill., is now superintendent of the Addressograph Company in the same city.

Daniel Hurley, connected with the engineering staff of the Vacuum Cleaner Company, New York City, has become a member of the firm of D. Hurley & Co., Providence, Rhode Island.

C. C. Jett, draftsman at the Ohio works of the Carnegie Steel Company, has severed his connection with that firm to join the engineering division of the Cleveland Machine and Manufacturing Company.

Carl L. Grohmann, until recently chief engineer with the National Cash Register Company, has become associated with the engineering staff of the Niles-Bement-Pond Company, at Hartford, Connecticut.

William H. Larkin, Jr., ex-works manager of the United Concrete Machinery Company, New York City, is at present engaged by the M. Rumely Company, La Porte, Indiana, introducing new cost and production order systems.

Carl Rigdon is at present filling the chair of assistant professor of experimental engineering at the Ohio State University. Mr. Rigdon has discontinued his former connection with the Westinghouse Machine Company as erecting engineer.

Henry G. Read, who has been a prominent figure in the mechanical world of Russia, has taken quarters at Omsk, Western Siberia, and will no doubt become somewhat of a pioneer in the mechanical field of this undeveloped country.

Adam de Traupe, who has been in business as contracting engineer in Philadelphia, has recently been forced to close his offices temporarily, due to poor health, and is now seeking rest and return of good health in the Adirondack mountains.

C. A. V. Carlson, formerly chief draftsman with the Chicago Pneumatic Tool Company's compressor works, Franklin, Penn., relinquished that position some time ago to enter the engineering department of the Atlas Engine Works, Indianapolis, Indiana.

Charles A. G. Winther, until recently employed by the Roe Nephews Manufacturing Company, at Detroit, Mich., in the capacity of manager, has established himself in business at 170 Summer street, Boston, Mass. Mr. Winther will follow the lines of a mechanical and consulting engineer.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

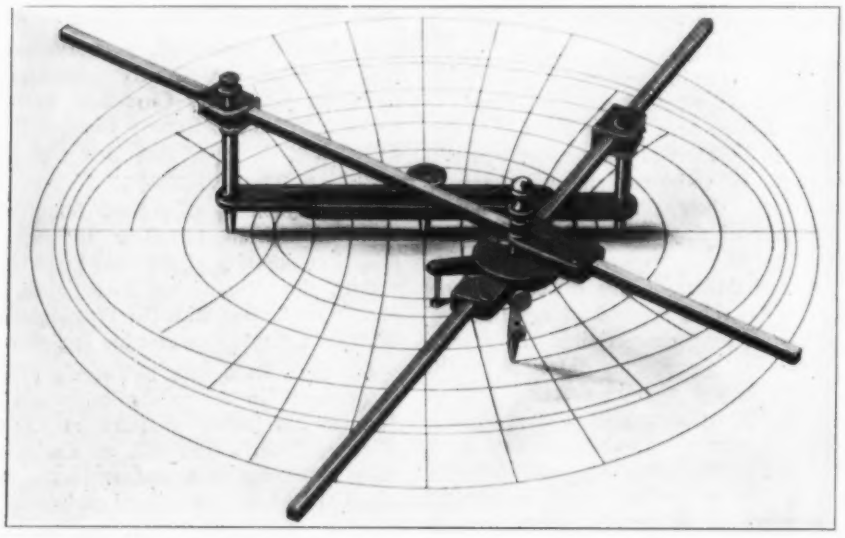
Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

An Instrument for Drawing the Curves of Conic Sections

This instrument is based on the principle that the sum or the difference, respectively, of the distances from any point of an ellipse or hyperbola to the foci of the curve is constant.

The instrument is constructed with two posts having points to be placed at the foci of the ellipse or hyperbola. These two posts are connected by slotted beams clamped together by a thumb screw. On the top of each post is a stationary pinion about which is swiveled a head. Passing through these heads and engaging each pinion are two racks, crossing each other, and both engaging a traveling pinion. Through the traveling pinion is a vertical shaft, at the bottom of which is connected a pen or pencil, and around the traveling pinion are two heads adapted to travel along the racks.



AN INSTRUMENT FOR DRAWING CONIC SECTIONS

If the instrument as shown in the half-tone, is put in motion by placing the hand at the top of the traveling-pinion shaft, the traveling pinion will revolve, moving in on one rack and out exactly the same distance on the other, thereby causing the pen to describe an ellipse which is mathematically correct.

By re-assembling the instrument so that the traveling pinion will pass between the two foci, the pen or pencil will be-scribe a hyperbola.

For drawing an ellipse with ink, it is necessary that the pen should always be tangent to the curve at the point which it is drawing. In other words, the pen has to be guided around the vertical shaft. The mechanism which accomplishes this purpose is based on the property of the ellipse or hyperbola that the tangent at each point of the curve bisects the angle between the two lines connecting this point with the foci of the curve. Each of the traveling heads is provided with a flange, in which is cut a spiral-shaped groove; the two grooves run in opposite directions. Between the two flanges there is a steel plate swiveled around the pinion and having a slot running in a radial direction. A pin engaging both of these grooves and also a slot in the plate between the two flanges causes this plate to revolve around the vertical shaft whenever the instrument is put in motion. The steel plate has an extension at the point opposite the radial slot, in the end of which is riveted a vertical pin engaging a hole at the end of a horizontal arm which is threaded into the head carrying the pen. By this arrangement the revolving motion of the steel plate is conveyed to the pen and the pen is properly directed.

By using an attachment, not shown in the cut, to take the place of one of the posts at the foot, and allowing this to slide along a T-square, a parabola will be described.

The instrument has recently been patented by Julius Degen, of Trenton, New Jersey.

A New Combination Punch and Die Press

The accompanying half-tone shows a new punch and die press which is being built by the Automatic Specialty Company, of Cincinnati, Ohio. It can be driven either by foot power or by a belt. It was designed for a small quick-acting punch press for sheet-metal or brass goods.

It will take any size punch up to ⅜ inch in diameter and will readily punch a hole of this size through brass or soft iron that is ⅛ inch thick.

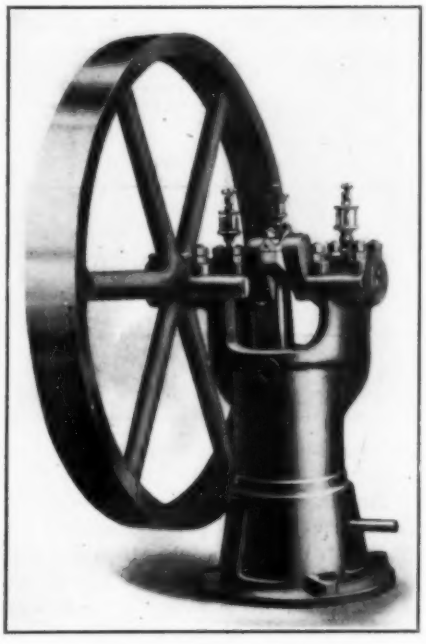
COMBINATION PUNCH AND DIE PRESS

The slide or ram is fitted with an adjustable gib to take up any wear which might appear, but it has a large area to reduce the wear to a minimum.

The press is equipped with a hand lever and a foot lever for releasing the clutch pin, and can be operated by either method. The fly-wheel is bronze bushed and the bolster plate is fitted with a front and side gage for guiding the stock to the punch where duplicate pieces are wanted.

A Belt-driven Air Compressor

To meet the requirement of shops having use for a small air compressor the Westinghouse Air Brake Company, Pittsburg, Penn., has developed the machine shown in the accompanying engraving.



BELT-DRIVEN AIR-COMPRESSOR

This has a cylinder 3x4 inches, the base is 12 inches in diameter, and the complete outfit weighs but 218 pounds. Its compactness enables it to be located in a very limited space at any point where power is available.

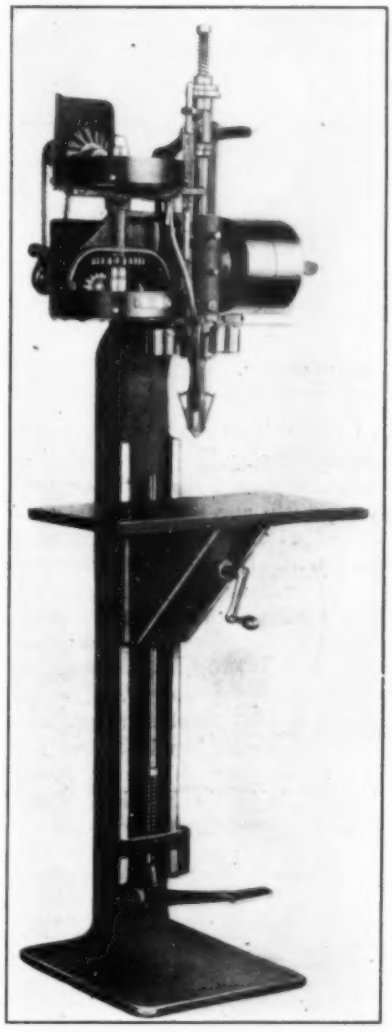
The cylinder is single acting and is water-jacketed, the rated capacity of the pump being 4 cubic feet of free air per minute at 250 revolutions. At this speed, which is its point of maximum efficiency, it will work against 200 pounds air pressure and requires one brake horse-power, but it can work against 250 pounds if required.

It has been particularly designed for gas-engine starting, automobile garage use, charging storage tanks for pneumatic tools or for general purposes where a comparatively small quantity of compressed air is required.

An Automatic Screw-driving Machine

In assembling small work in large quantities the problem of putting in the screws becomes important, as the constant use of a screwdriver, even of the rapid, ratchet or other variety, is very apt to put a gain twist in the arms or wrist of any operator after a short time. To make the putting in of screws easier and much more rapid, the Reynolds Machine Company, Rock Island, Ill., brought out a machine which has now been improved as shown herewith.

The new machine is provided with two hoppers, so that two sizes of screws can be handled on the same job, not at once but in any succession desired. These hoppers contain a revolving-disk feed which carries the screws, head up, to the slide or chute and drops one after the other to the spring jaws at the lower end of the spindle. It has been found simpler to let both magazines drop a screw each time and let the unused screws fall into the proper cup, to be dumped back into the hopper when necessary, than to introduce any selective device into the mechanism.



AUTOMATIC SCREW-DRIVING MACHINE

The screw is held in the spring jaws, the screwdriver finding its way into the slot; a pressure on the foot lever brings down the driving spindle through a back-lever connection and at the same time slightly raises the table by means of the cam and roller at the lower end of the screw. This raising of the table clamps the work between the table and the screw guide, and the further movement drives the screw into place.

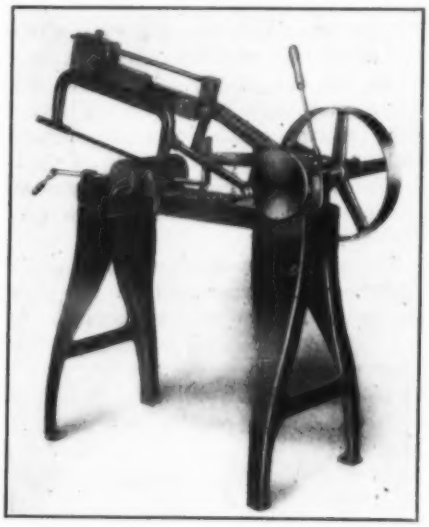
The spindle is driven by the two friction collars at the top, under control of the spring above; when the screw is driven home, these collars slip until the foot is released, a new screw drops into place and the operator brings a new piece or a new hole under the screwdriver.

The table is adjusted for various thicknesses of work through spiral gears and the vertical screw, and the machines are used both to drive wood and machine screws in assembling work in quantities. In many places this enables wood screws to be driven without first boring the holes, and the machine will drive more than the screw will stand in any case, and without marring the heads of even brass screws. When it is considered that the spindle runs from 1000 to 1500 revolutions per minute, it is readily seen that the capacity of the machine is limited only by the ability of an operator to get work under the spindle.

The machine is made in three sizes and with one or two hoppers as desired, also with an attachment so that screws can be driven close up inside the corners of boxes and similar places. The largest machine will handle wood or machine screws up to 2½ inches long.

Power Hack Saw without Drag

The power hack saw shown with this differs from the usual design of this now common tool, in having an automatic lifter for the saw blade which relieves the drag



POWER HACK SAW WHICH LIFTS SAW ON BACK STROKE

on the backward stroke. Behind the crank disk which drives the saw is an edge cam on which rests a roller carried by the lever hinged at the back and connecting with the L-shaped piece which rests on the two set screws.

In its lower position the hardened-steel dog on top of the L-shaped piece just clears the ratchet teeth on the inside of the curved rack at the back of the saw guide, so that the saw can be fed down into the work by the weight above. But on the return stroke the cam lifts the

lever, the steel dog catches the teeth of the rack and the saw is lifted away from the metal so as to prevent the usual drag.

The makers, the Racine Gas Engine Company, Racine Junction, Wis., claim that this lengthens the life of the saw very materially so that they have no trouble in making six cuts through a 6-inch crucible-steel bar with one blade.

An Automatic Slot-milling Machine

The work done by this machine and shown in Fig. 2 is for use in knitting machinery, and the advantage of doing this automatically on a small machine, instead of tying up a regular milling machine, is obvious to any mechanic.

The work is held by an expanding-ring washer which is controlled by the nut in the center. This is on a plunger which is controlled by a heavy spiral spring that takes the strain from the index lock and is held down until the work is completed, when it is released by a lever at the bottom so that a new blank can be inserted.

The machine as shown is ready to start on a cut, feeding out from the center under control of the face cam at the back end of the ram or slide which carries the saw head. The edge cam this side of the face cam controls the vertical movement of the saw, which in this case makes a straight cut across the face of the ring and then is forced down so as to make a square cut at the outer edge of the ring. These movements can be easily traced from the cams which give positive control to both movements. The depth of cut is regulated by the micrometer adjustment on top of the depth stud shown over the saw.

The indexing mechanism is beneath the table and is so constructed that any number of teeth from one to fifteen can be taken at each step. In addition to this there is a positive lock on the index so that after the ratchet has carried the wheel the desired number of teeth, the index and work are held firmly while the cut is being taken.

The work shown is a bronze ring, 8 inches in diameter with 140 slots, which were cut in 45 minutes, including the time required to change the work for another piece, and it is also arranged to slot screw heads of all sizes and styles by using a hopper feed. In either case the machine is fully automatic.

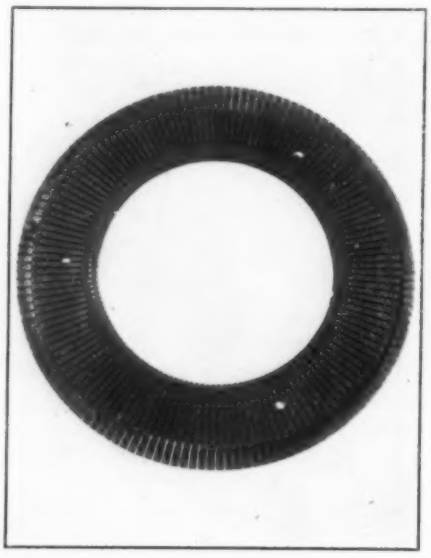


FIG. 2. SLOTTED DISK FOR KNITTING MACHINE

The machine requires bench space of about 16 inches in width by 30 inches in length and, together with countershaft, weighs about 225 pounds. The cutter runs about 2000 revolutions per minute and work can be handled from 3 to 8 inches in diameter.

It is made by the Standard Manufacturing Company, Bridgeport, Conn.

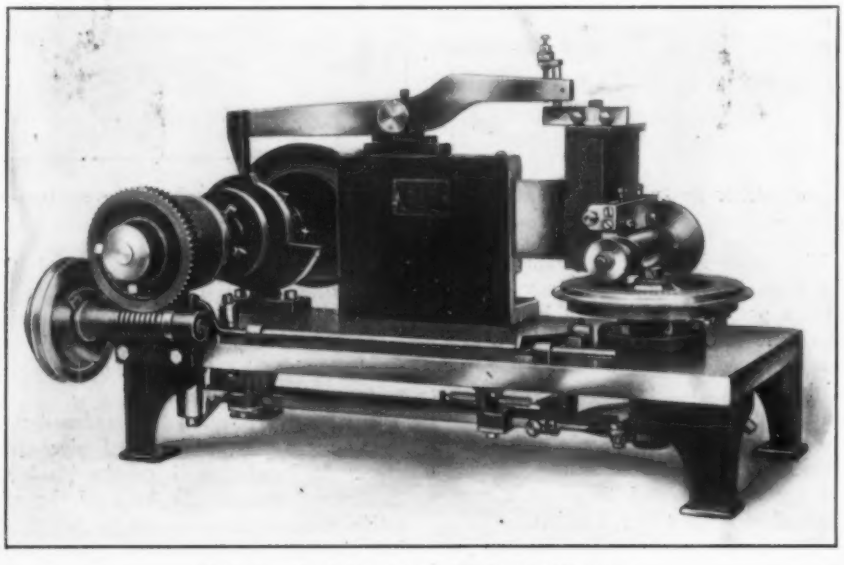
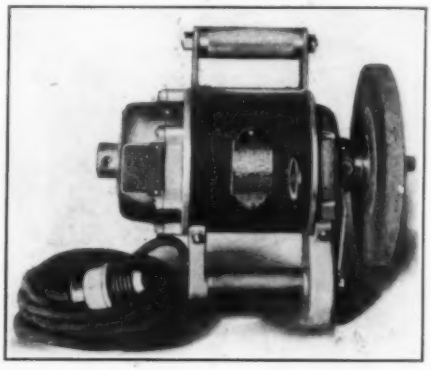


FIG. 1. AUTOMATIC SLOT-MILLING MACHINE

Portable Grinding and Buffing Machine

The half-tone illustrates a portable grinder and buffer. The operating and controlling switch is located in the right-hand handle of the machine, obviating the necessity of the operator releasing his hold on the machine for starting and stopping. The bearings are of phosphor bronze arranged for convenient lubrication and provided with dust-proof oilers. The machine is air cooled by a rotary fan mounted directly on the armature shaft. It is arranged so that a buffing wheel or special-shaped emery wheel can be interchanged, and is furnished with an emery wheel 8 inches in diameter by ¾ inch face. The machine may be used in engine, dynamo rooms, etc., for buffing up bright parts. Another application of this machine is in sheet-metal and drop-forging shops, where dies can be ground with it while they are in the press. The machine has an eye-bolt fitted at the top so that it can be suspended from a spring or provided with a cord and counterbalance, relieving the operator of the weight, if so desired. The machine weighs 25 pounds complete and is furnished for 110, 220 and 550 volts direct current. It can also be wound for any special voltage from 75 to 650. Power is taken from any ordinary lamp socket. The Cincinnati Electrical Tool Company is the maker.



PORTABLE GRINDING AND BUFFING MACHINE

Dial Measuring Gages

The makers of these instruments have made use of gear trains in much the same manner as in a watch, for the purpose of indicating and measuring small work, such as occurs in watch and clock making and small instrument work. They are also designed for small and fine measurements of almost any material such as wire or paper, where accuracy and quick readings are important features.

The gage shown in Fig. 1 has a parallel motion to its jaws and connects through rack and pinion to the train of spur gearing inside. Although built on the line of

a watch, it is made sufficiently heavy and strong to withstand any shop usage that a tool of this kind is likely to receive.

As shown, it is made to measure thousandths of an inch, and it will indicate a much smaller amount than this which can be estimated by the position of the hand or pointer between the division. It has a capacity of 2 inches, giving it quite a

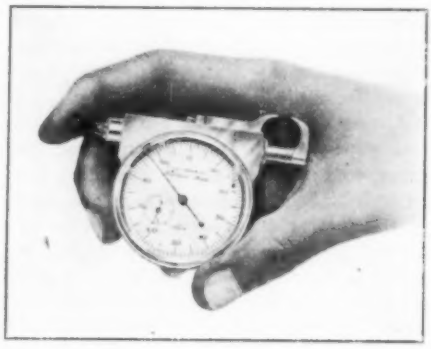


FIG. 1. DIAL JAW GAGE

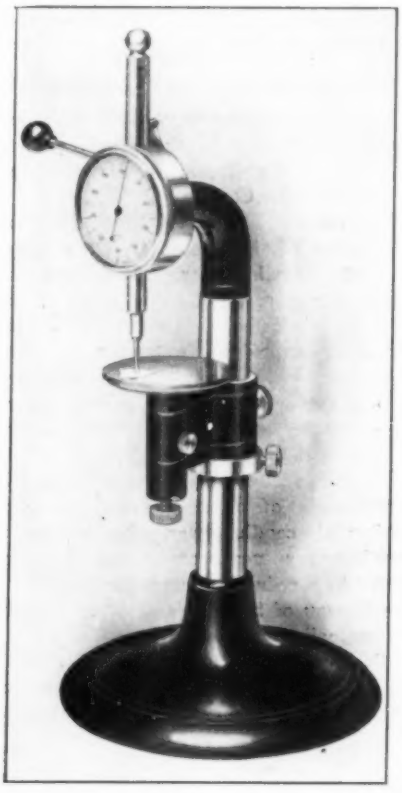


FIG. 2. DIAL INDICATOR ON STAND

wide range, and each revolution of the large hand indicates ½ inch opening of the jaws. The small hand shows the number of revolutions which have been made by the large hand. This instrument can be used either in the hand as shown, or it can be set on the bench, being provided for that purpose.

Fig. 2 shows one of these instruments incorporated into what may be called a measuring stand, and, as shown, is being used to measure the thickness of a piece of paper placed between the measuring point and the table. An instrument very similar to this is also made to be used in the hands in much the same way as the jaw gage shown in Fig. 1.

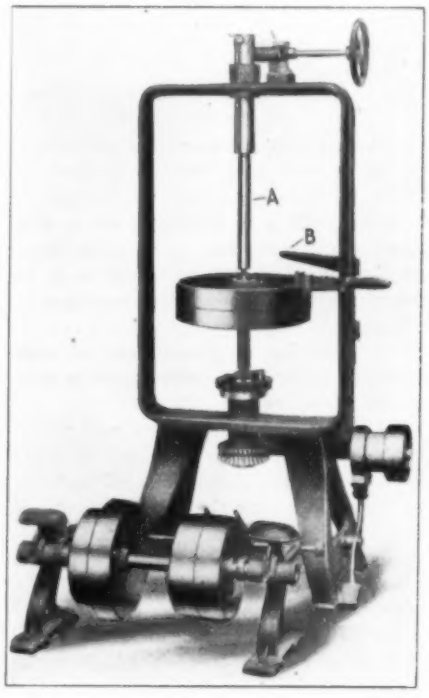
The table is free to turn on its center, and is provided with a fine adjusting screw for bringing it up to such a hight that the hand of the gage may indicate zero when the end of the measuring rod rests on the table itself, or against the surface of any standard gage, which may be used in making comparative measurements. In this way a large range of work can be handled by a single instrument.

In all of these the measuring is done by the tension of a spring so that there is no element of personal touch, as the jaws will bear with equal pressure without regard to the person using the instrument. This is particularly useful in measuring soft material, such as sheet rubber.

Toolmakers will find many uses for an intrument of this kind, as it can be used as a center indicator, or limit gage, or can be adapted for measuring the pitch of screw threads for gage testing. These are made by B. C. Ames & Co., Waltham, Mass.

The "Currier" Reaming Machine

A power-driven machine for "hand reaming" is illustrated by the accompanying half-tone. The frame has two spindles in perfect alinement, one in the upper and the other in the lower section. The lower one is arranged to be driven by power through a worm and wheel, contains a hardened steel center and has an equalizing driver for the reamer. A foot-operated brake is fitted to the pulley on the worm shaft so that it can be stopped at will.



"CURRIER" REAMING MACHINE

The upper spindle has a vertical movement and is operated by hand through a rack and pinion. It carries the spindle *A* upon which the work to be reamed is placed and which has a hardened steel center in its lower end.

The work to be reamed is first chucked and is then slipped over the bar *A* and held up by the arm *B* while the reamer is being placed in position. The machine is then started and the work is fed down by gravity. A wrench makes a convenient way of keeping it from rotating as shown in the illustration.

The machine has a capacity of work diameter up to 24 inches. Ordinary hand reamers are used but the shanks should preferably be fluted. It is built by J. E. Snyder & Son, of Worcester, Mass.

A Bit of Tapmaking History

The tapmaking industry in America probably dates back to about 1829, when Daniel King, of Waterford, N. Y., began, in a quiet way and without any idea that tapmaking would grow to its present proportions, to make taps for blacksmiths. Blacksmiths' taps in those days were even more crude than they are now, and even today they are hardly first cousins to machinists' taps. They answer their purpose, but have many points of difference besides the taper.

The machinists' tap had its beginning in a commercial way when, in 1866, Benjamin Bee started a little shop in North Harwich, Mass., way down on Cape Cod. Benjamin Bee was a mechanical genius, according to all accounts, and began by milling the threads in all his taps long before Horton began to use this process in making the screws for his well known chucks, which was about 1873.

The milling cutters could not be ground after hardening, for the very good reason that grinding machines were unknown, and Ben Bee, as those who knew him always called him, devised a very ingenious way of overcoming the "wabble" of the milling cutter, due to springing in hardening.

His method was to drive the cutter with a feather, which would allow it to move sidewise a little, and hold it in position for cutting by a spring which always kept the cutting edge against a hardened-steel plate. This answered very nicely for the grade of accuracy required at that stage of the game.

But the old shop was burned and Bee had financial difficulties such as too often beset the mechanic without a business training; finally a sort of stock company was formed to carry it on. Some of the stockholders lived in Bridgeport, and

Cape Cod seemed very much out of the way to them. So, in spite of Bee's fondness for Cape Cod, the business came to Connecticut, where it continued with a sort of struggling existence for several years as the New York Tap and Die Company.

During one of its uncertain periods when something had to be done to lower the cost of production, one of the mechanics connected with the company, Alfred Goddard by name, devised a tool for chasing the threads and relieving them at the same time. This was practically a multiple tool holder or head with six or eight threading tools arranged so that the first tool cut a partial depth, the second took a deeper cut and so on until the last one finished the thread.

This tool holder also had an "in and out" movement for relieving the threads as they were cut. If there were six flutes in the tap, a six-lobe cam was used to feed the tool in the amount of the clearance every time the proper place arrived on the tap blank.

The result was a threaded tap which was of itself a six-sided cam; the flutes were then milled at the proper place to bring the cutting edge at the highest point. If there was any lost motion, the amount of backing behind the cutting edge might be very little indeed, or it might extend almost to the next high spot; but it was a very ingenious device and seems to have been the forerunner of the now well known backing-off attachment and of the Rivett-Dock threading tool.

The New York Tap and Die Company finally succumbed to the fate of so many pioneer concerns, and went out of business along in the late "seventies."

In the meantime J. M. Carpenter had seen the need of commercial standard taps and had started, in 1870, with one man, so that this left him the oldest machinists' tapmaker in the country.

The American Screw Company had begun to be a large factor in the machine business and was continually being asked to supply taps for its machine screws, as there were none on the market.

It is rather difficult to realize a situation where standard screws or bolts can be bought, but where the taps have to be made in the shop using them; so, to help out its customers, the American Screw Company made a few machine screw taps under protest, as its business was screws and it was one of the pioneers in recognizing the advantage of making one thing and devoting all its time to that.

Carpenter was not far away and being impressed with his mechanical and business abilities, the American Screw Company arranged to furnish him with a set of standard gages for its screws if he would make a line of taps to suit and have them on sale so that orders could be filled promptly. This was the beginning of the machine-screw tap as a commercial article, and this set of standard gages is the only set in existence outside of the American Screw Company.

This in a way accounts for the discrepancy in screw gages and the troubles which led to the adoption of the new standard. As the new screw companies came into the field, they naturally made their screws as near to the American Screw Company standard as could be measured from screws bought in the open market. With the methods for making less perfected than they are today there was naturally more difference than would be found now, and this is why one maker's screws will not always interchange with another's.

The J. M. Carpenter Tap and Die Company is the outgrowth of the little shop with its one man, and J. M. Carpenter is still the moving spirit in the business.

Specifications for Electric Lamps

The United States Navy Department has recently prepared and published a set of standard specifications for electric lamps, which are herewith reprinted with the omission of such sections as apply to special lamps.

1. Samples

To show construction, bidders must, if requested, submit two samples of each type of lamps proposed to be furnished. All lamps must conform to the samples submitted, in shape of bulb, mechanical construction and type of filament, and no departure from the sample lamps will be permitted without the written permission of the department.

2. Comparative Tests

In determining the award of a contract the department may require bidders to submit for a comparative test 500 lamps. Such test will be conducted with a procedure similar to that outlined in these specifications for inspection and tests of lamps ordered under contract, modified as follows:

(*a*) Inspection of 50 per cent. of each lot of 500 lamps to discover faults in construction and sorting.

(*b*) A determination of the uniformity, or non-uniformity, of rating and the characteristics of the distribution of light of the lamp, including the measurements of about 100 lamps of each lot of 500 to determine the mean horizontal, tip and mean spherical candle-power, together with the current consumption.

(*c*) Determination of mean spherical candle-power performance throughout the useful life of 25 lamps of each lot of 500 submitted, operated at voltage corresponding to an initial specific consumption of 3 watts per mean spherical candle.

3. Standard Incandescent Lamps

Incandescent lamps to be furnished under this contract shall be new lamps and shall be guaranteed to be in accordance with the following specifications.

4. General Conditions

The provisions of these specifications shall be binding upon all lamps specially mentioned herein, or in schedules, by voltage, candle-power, watts per candle, type and base, and upon no other lamps, except by mutual written agreement.

These specifications shall not apply to any frosted, colored or other lamps than with the usual clear glass bulbs unless otherwise specifically included. Frosted lamps shall be represented in initial tests, inspection and life tests by bare lamps selected from the lots before frosting.

All tests shall be made (in a competent and expert engineering manner) at the expense of the Government, excepting that when initial inspection and tests are made at the factory the contractor will be required to supply the necessary equipment, assistance, current and facility for making the tests. The manufacturer, or his agent, shall have the privilege of witnessing and verifying all tests of his lamps made hereunder, and shall also be privileged to obtain copies of the tests of his lamps, and have access to the records of such tests at all reasonable times.

5. Definitions and Standards

Unit of candle-power—The unit of candle-power shall be the candle as determined by the Bureau of Standards at Washington, D. C.

Photometric measure—The basis of comparison of all lamps shall be the same spherical candle-power. The nominal candle-power referred to in these specifications shall be the mean horizontal candle-power of lamps having a mean spherical candle-power value of 82.5 per cent. of the mean horizontal candle-power, which is the standard value for filaments of the oval anchored type.

For lamps having filaments giving a different ratio of mean spherical to mean horizontal candle-power, the horizontal candle-power measurement will be corrected by a reduction factor determined by the Bureau of Standards or other authority mutually agreed upon.

Test quantity—The test quantity shall consist of 10 per cent or more of any lot or package, and in no case be less than 10 lamps.

6. Methods of Test

From each package there will be selected at random the test quantity for the purpose of determining the mechanical and physical characteristics of the lamps, the individual limits of candle-power and watts per lamp, and finally the life and candle-power maintenance. These lamps will be known as the test lamps.

7. Mechanical and Physical Characteristics

All lamps shall conform to the manufacturers' standard shapes and sizes of bulbs and to the standard forms of filament, and the standard candle-power and watts per lamp.

8. BULBS

All bulbs shall be uniform in size and shape, clear, clean, and free from flaws and blemishes.

9. BASES

All lamps, unless otherwise specified, shall be fitted with the standard Edison screw base, fitted with glass buttons, forming the insulation between contacts and rendered impervious to moisture. The shells of the bases shall be of good-quality brass, firmly and accurately fitted to the bulb with moisture-proof cement, and in length to conform to the National Electric Code of Fire Underwriters.

10. FILAMENTS

The lamp filament must be symmetrically disposed in the bulb and shall not droop excessively during the life of the lamp when the lamp is burned on test in the one horizontal position at a voltage corresponding to an initial specific consumption of 3.76 watts per mean spherical candle and without excessive vibration.

All filaments must be uniform and free from all imperfections, spots and discolorations.

11. LEADING IN WIRES

Leading in wires must be fused into the glass with the joints between copper and platinum wires bedded well within the glass; the wires to be straight, well separated, and securely soldered to the base and cap, without excess of solder and so threads of base are free from solder.

12. VACUUM

All lamps must have first-class vacuum, showing the characteristic glow of good vacuum when tested on an induction coil.

13. MARKING

A printed label, showing manufacturer's name or trademark, voltage, and candle-power, must be placed on each lamp near base.

14. IN GENERAL

The lamps must be well made and free from all defects and imperfections, so as to satisfactorily meet the conditions of the lighting service.

15. REJECTION FOR DEFECTS

If 10 per cent. of the test quantity of lamps selected from any package show any physical defects incompatible with good workmanship, good service, or any clause of the specifications, the entire lot from which these lamps were selected may be rejected without further test when tests are made at the lamp factory. When the tests are made elsewhere, if the first test quantity prove unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of this second lot of sample lamps be found to have any of the physical defects above mentioned, the entire lot from which these lamps were selected may be rejected without further test.

16. INITIAL LIMITS

When tested at rated voltage the test lamps shall not exceed the limits given in schedule. If 10 per cent. of test lamps from any package is found to fall beyond the limits stated, when tests are made at the lamp factory, the entire lot from which these lamps were selected may be rejected without further test. When tests are made elsewhere, if the first test quantity prove unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of these additional lamps be found to fall beyond the limits, the entire package may be rejected without further test.

17. LIFE AND CANDLE-POWER MAINTENANCE

Life tests shall be made as follows: From each accepted package of lamps two sample lamps shall be selected which approximate most closely to the average of the *test quantity*. One of the two lamps thus selected will be subjected to a life test and designated as the *life test lamp*, the second or duplicate lamp being reserved to replace this *test lamp* in case of accidental breakage or damage during the life test. *The test lamps* shall be operated for candle-power performance at constant

RATING.		INITIAL LIMITS.				AVERAGE PERFORMANCE.
Rated Candle-power, Mean Horizontal.	Initial Watts per Mean Horizontal Candle.	Individual Candle-power Limits.	Mean Candle-power Limits.	Individual Watts per Lamp Limits.	Mean Watts per Lamp Limits.	Useful or Effective Life in Hours to 20 Per Cent. Drop in Candle-power at 3.1 Watts per Candle.
4	4.8	1 c.-p. above and 1 c.-p. below.	0.6 c.-p. above and 0.6 c.-p. below.	12 per cent. above and 12 per cent. below.	6 per cent. above and 6 per cent. below.	300
5	4.2	do	do	do	do	300
6	3.7	do	do	do	do	300
8	3.1	do	do	10 per cent. above and 10 per cent. below.	5 per cent. above and 5 per cent. below.	300
	3.6	do	do			330
10	3.1	do	do	do	do	330
	3.6	do	do	do	do	390
12½	3.1	do	do	do	do	390
	3.6	do	do	do	do	450
16	3.1	7½ per cent. above and 7½ per cent. below.	2½ per cent. above and 2½ per cent. below.	5.5 per cent. above and 5.5 per cent. below.	2½ per cent. above and 2½ per cent. below.	450
	3.5					420
20	3.05	do	do	do	do	420
	3.5	do	do	do	do	350
24	3.1	do	do	do	do	350
25	3.6	do	do	do	do	430
32	3.1	do	do	do	do	430
	3.6	do	do	do	do	400
50	3.6	do	do	do	do	300
75	3.6	do	do	do	do	....
100	3.6	do	do	do	do	....

VALUES FOR OVAL ANCHORED 100- to 120-VOLT PLAIN STANDARD LIGHTING LAMPS.*

*It is recommended that every effort be made to avoid ordering lamps of actual voltage of 105 and below, at 109, 110, and 111, 120, and above, and from 218 to 222, inclusive.

8	4.4	2 c.-p. above and 2 c.-p. below.	1 c.-p. above and 1 c.-p. below.	15 per cent. above and 15 per cent. below.	7½ per cent. above and 7½ per cent. below.	120
	4.4					
10	4.25	do	do	do	do	130
16	3.8	15 per cent. above and 15 per cent. below.	7½ per cent. above and 7½ per cent. below.	12 per cent. above and 12 per cent. below.	6 per cent. above and 6 per cent. below.	160
20	3.8	do	do	do	do	160
24	3.8	do	do	do	do	150
32	3.8	do	do	do	do	150
50	3.8	do	do	do	do	120

VALUES FOR OVAL ANCHORED 200- to 250-VOLT PLAIN STANDARD LIGHTING LAMPS.

potential, average variations of voltage not to exceed one-fourth of 1 per cent., either side. The voltage for each lamp shall be that corresponding to an initial specific consumption of 3.76 watts per mean spherical candle, or, if tested upon a different basis, the results shall be corrected to a basis of 3.76 watts per mean spherical candle. If desired the life tests may be made at such other watts per candle as may be mutually agreed upon.

Readings for candle-power and wattage shall be taken during life at the marked voltage of the lamps at approximately 50 hours, and at least every 100 hours afterward until the candle-power shall have fallen 20 per cent. below the initial candle-power, or until the lamp breaks, if within that period. The number of hours the lamp burns until the candle-power has decreased to 80 per cent. of its initial value, or until the lamp breaks, is known as the useful or effective life.

The average candle-power of lamps during life shall not be less than 91 per cent. of their initial candle-power. In computing the results of test of a lot of lamps the average candle-power during life shall be taken as the arithmetical mean of the values for the individual lamps of the lot tested.

Lamps selected for the life test, which for any reason do not start on such test, shall be replaced by others.

Lamps which are accidentally broken but not burned out on test shall not be counted to diminish the average performance.

In case both test and duplicate lamps are broken or damaged before the life test is completed, the average performance of all lamps of the same class previously determined under the same contract shall be assigned to the package represented.

On all tests for determining average candle-power and life each package which will be affected by the results of test shall have at least one lamp on such test.

Accurate recording voltmeter records will be obtained during the test on lamps to show the average variation on the circuit.

When so tested the lamps shall average at least the values for useful life given in the following tables:

(*a*) Values for Oval Anchored Plain Standard Lighting Lamps

Lamps of this type of voltages 105 and below, at 110, 120, and above, and also at 220, may have double the limits of variation in the initial limits specified for their respective classes.

Lamps and other types of filaments to give equivalent performances.

For lamps between 120 and 125 volts, the useful life values shall be 95 per cent. of those given in the table, and for lamps between 126 and 130 volts the useful life values shall be 90 per cent. of those given in the table.

(*b*) Values for Round-bulb, Tubular, and Other Irregular Types of Lamps

The individual limits for irregular types of lamps, such as round-bulb and tubular lamps, shall be twice the individual limits given in the body of the preceding schedules for regular lamps of corresponding candle-powers.

The individual limits for metalized filament and round bulbs primo types of lamps shall be 15 per cent. above and 15 per cent. below the mean candle-power rating, and 15 per cent. above and 15 per cent. below the mean total watt rating. The candle-power ratings referred to are the mean horizontal candle-power ratings of clear lamps without reflectors.

The department reserves the right to modify the method of test procedure in any particular, whenever such change is desirable, to secure test results in a more practicable, representative, or accurate manner. Such changes will be made, however, with the full knowledge and consent of contractor.

18. Rejections and Penalties

The failure of the lamps in any package to conform to the specifications as to mechanical and physical characteristics, or to initial limits, may cause the rejection of the entire package.

The failure of the lamps to give within 90 per cent. of the values of useful life given in the tables may cause the cancellation of the contract.

Lamps which have not been used and are rejected under the terms of these specifications will be returned to the manufacturer at his expense, and no payment will be made therefor.

Prompt notice will be served upon the contractor of the test results on lamps that are rejected, or that fail to meet the specified requiremens.

Navy Department, June 14, 1907.

A Large Blue Print

That continuous blue printing is more than a name can be seen from the illustrations of a blue print recently made in Washington, D. C., on one of the Revolute blue-printing machines in one of the Government offices in that city. As the blue print contains details of the extension now being made to the United States Capitol, it is fitting that this building should be shown in the background. This blue print is 54 inches wide and 120 feet long, and contains 540 square feet of paper in a single piece.

A BLUE PRINT 120 FEET LONG

The absence of any lines or details on the print, which are lost in the illustrations, gives it the appearance of a temporary fence which is being held in position by six men and might easily be imagined as the device of some overzealous constable for preventing automobiles speeding beyond the limits of the law.

These blue-printing machines are made by the Revolute Machine Tool Company, 523 West Forty-fifth street, New York City.

Good work with poor tools is not as creditable as better work with the best equipment.

Drill Heads for Closely Spaced Holes

In the article that appeared under this heading at page 900 we inadvertently omitted the address of the Langelier Manufacturing Company, which is Providence, R. I.

Tests of Reinforced Concrete Beams

Bulletin No. 14 has just been issued by the University of Illinois Engineering Experiment Station. The tests described are a continuation of the tests discussed in Bulletin No. 4. The topics investigated include the effect of quality of concrete upon the strength of beams, the effect of repetitive loading upon the action of beams, and the resistance of beams to diagonal tension failures. The results of the investigation of diagonal tension failures throw light upon the amount of the vertical shearing stress which may be allowed in reinforced concrete beams not having metallic web reinforcement. The resistance of beams to diagonal tension may be the controlling feature of relatively short beams, and as such failures occur suddenly and without much warning, a knowledge of the resistance of the concrete is essential. Some beams gave surprisingly low values and it seems evident that the values allowed by many city building ordinances are higher than should be recommended. The tests of concrete columns, reinforced concrete columns and of reinforced concrete T-beams for 1906 have already been published.

Obituary

Thomas F. Rowland, engineer and shipbuilder, died at his home in New York City, December 13, 76 years old. In early life Mr. Rowland became a marine engineer and later designed the machinery for the gunboat "Seminole," eventually going into the ship-building business. During the Civil War he with his associates constructed the "original monitor."

Lord Kelvin, better known as Sir William Thomson, Great Britain's foremost scientist, died at Glasgow, Scotland, December 17, in his 84th year. Until the time of his death Kelvin was without dispute the greatest living scientific genius and his remarkable theories invariably resulted in practical applications. His world-wide recognition came principally from his perfecting submarine telegraphy, for it was he who overcame the difficulty of one signal confusing the effect of the next following one, which trouble was encountered after the first Atlantic cable was laid. He was the inventor of many calculating machines, and his compass is universally used in maritime circles. The highest scientific honors were bestowed upon him and in the last years of his life he was very active as president of the Royal Society of Edinburgh.

Business Items

A. P. Witteman & Co. have moved their Boston office from the Mason building to larger quarters in the Machinery Exchange, 11 Oliver street.

The United States Gas Furnace Company, 159 Aborn street, Providence, R. I., has been organized and is building a line of gas blast furnaces for hardening, tempering, etc. W. E. Chase is general manager.

Chicago Flexible Shaft Company, 162 Ontario street, Chicago, Ill., has opened a branch at 11 Denmaris street, Charing Cross Road, London, W. C., where a complete line of its furnaces will be handled.

The Curtis & Curtis Company, Bridgeport, Conn., has completed large additions to its works, and with the increased facilities will be better able to meet the constantly growing demand for its Forbes patent die stocks.

Thomas W. Pangborn Company, manufacturers, dealers and agents in pattern and machine shop supplies, foundry equipment, etc., will do business after January 1, 1908, under the form of a corporation, the active management of the concern remaining unchanged.

The Ingle Machine Company, of Rochester, N. Y., has moved its shop from Mill street to its new building on St. Paul street near the New York Central station, where it will have more than double the space and a thoroughly up-to-date equipment of tools to handle contract and special work.

A new field with large possibilites for all classes of machinery seems to be open in western Siberia, according to a report from Henry G. Read, formerly of Charkov, Russia, who has just taken up quarters at Omsk, Western Siberia with the idea of becoming thoroughly acquainted with the conditions. Mr. Read will no doubt be a good man for those looking for business in that section of the world to get in touch with.

Trade Catalogs

The Jacobs Manufacturing Company, Hartford, Conn. Catalog of Jacobs improved drill chuck. Illustrated, 6x9 inches, paper.

The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. Catalog describing different styles of lathes. Illustrated, 104 pages, 6x9 inches, paper.

Wagner Electric Manufacturing Company, St. Louis, Mo. Bulletin illustrating the use of the polyphase motor in the shop. 32 pages, 8x10 inches, paper.

United Engineering and Foundry Company, Pittsburg, Penn. Catalog describing lever and vertical shears. Illustrated, 74 pages, 8½x10 inches, paper.

The Connersville Blower Company, Connersville, Ind. Catalog No. 10 on positive pressure blowers, gas exhausters, etc. Illustrated, 48 pages, 6x9 inches, paper.

Newton Machine Tool Works, Twenty-fourth and Vine streets, Philadelphia, Penn. Catalog No. 45 describing complete line of tools. Illustrated, 304 pages, 6x9 inches, cloth.

Cling-Surface Company, 1032-1048 Niagara street, Buffalo, N. Y. Catalog and treatise on "The Treatment of Belts and Ropes for Service and Profit. Illustrated, 88 pages, 4½x7 inches, paper.

General Electric Company, Schenectady, N. Y. Bulletin No. 4549, illustrating and describing Thomson high torque induction test meter, type IB-2. Bulletin No. 4552, illustrating and describing direct current instruments, type D.

Manufacturers

The Dixie Trunk Company, Park City, Tenn., will build a new factory.

The Paragon Plaster Company, Syracuse, N. Y., will erect a new factory.

The Oak Cliff Paper Mill Company, Dallas, Texas, will erect a new plant.

Smith, Hinchman & Grylls, Detroit, Mich., will erect a one-story brick foundry.

The St. Paul Mill (Minn.) and Elevator Company may establish a plant in Vidalia, La.

The Transit Thresher Company, Minneapolis, Minn., has let contract for a new plant.

A machine shop will be erected for the Chicago House Wrecking Company, Chicago, Ill.

The Lynn (Mass.) Car Company is erecting a plant for the manufacture of commercial vehicles.

The Pioneer Pole and Shaft Company, Arkadelphia, Ark., will rebuild plant recently destroyed by fire.

The National Enameling and Stamping Company, Milwaukee, Wis., has let contract for a $25,000 factory.

The Stanford Steel Range Company, of Sheffield, Ala., contemplates establishing a foundry in Norfolk, Va.

Plans have been completed for the new plant of the American Case and Register Company, Salem, Ohio.

The Continental Can Company, of Baltimore, Md., will erect a four-story factory building at Highlandtown.

American Car and Foundry Company, of St. Louis, Mo., has had plans prepared for repair shop at St. Charles.

The Worswick-Haardt Harvester Company, Montgomery, Ala., has been incorporated with $500,000 capital stock to manufacture cotton harvesting machinery and implements, motors, etc. Incorporators, J. E. Worswick, George P. Haardt and others.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work a specialty. E. O. Chase, Newark, N. J.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machinery Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Mechanics, write for our special offer of how to get a set of wrenches free. Bullard Automatic Wrench Co., Providence, R. I.

Wanted—A second-hand patternmakers' lathe of modern type, 16 in. by 6 ft.; give full description. Box 724, AMER. MACHINIST.

Wanted—The following second-hand machinery; one forging machine, two turret lathes, one bolt cutter, one 24"x16' engine lathe. Box 687, AMERICAN MACHINIST.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

In evenings, invent for profit; waste of money to engage non-mechanical patent attorney; no other attorney is member both A. S. M. E., and A. I. E. E.; mail invention for free advice, etc. E. P. Thompson, M. E., registered patent attorney, Suite 40, 39 Cortlandt St., New York.

Machine work wanted; manufacturing company conveniently located in middle west with good shipping facilities; large new machine shop equipped with modern labor saving tools driven by individual variable speed motors, full complement traveling cranes, has surplus capacity, and would like an opportunity of figuring on machine work of any class from 16' diameter down; prepared to do machining alone or to furnish either steel or iron castings completely machined to gauge. Box 697, AMERICAN MACHINIST.

We want to purchase or handle the patents or designs for a line of machinists' tools or machine shop specialties; would prefer to take up some entirely new tools or a noticeably new design; we are willing to consider either the purchase of patent, manufacturing under royalty, or the introduction and selling of new tools, the manufacture of which is already started; we are located in New England and are experienced manufacturers and also salesmen of wide acquaintance and influence and wish to use this experience in bringing out a line of specialties. Address with full particulars. Box 725, AM. MACH.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Machine shop foreman wishes a position; experienced on engines and machinery of all kinds; excellent references. S. T., Box 721, AMERICAN MACHINIST.

GEORGIA

Patternmaker having eight years' experience on high-grade manufacturing and jobbing shop patterns; desires change and permanent position where attention to duty, ability and energy will be appreciated; reference given from past and present employers. Box 718, AMERICAN MACHINIST.

ILLINOIS

Gas power engineer, experienced in installation, operation and design of gas producers, engines and furnaces wishes engagement with substantial concern in gas power line; expert and experienced in mill construction, foundations, power transmission, steam, gas and electric power costs; technical and practical; sales or construction. Box 722, A. M.

MARYLAND

Position of trust or responsibility by experienced executive office man; correspondent, systematizer; exact, thorough; go anywhere. Address "Reliable," AMERICAN MACHINIST.

NEW HAMPSHIRE

Situation wanted by a foreman blacksmith; will go to any part of United States or Mexico; one who has had large experience on locomotive, car, marine engineering and general jobbing work; a good man on steel work such as tool dressing, tempering and case-hardening. Box 717, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 726, AMERICAN MACHINIST.

Mechanical and electrical draftsman, technical graduate, seeks position anywhere. Address "Experienced," AMERICAN MACHINIST.

Mechanical draftsman will be open for position about Jan. 6, 1908; one and one half years in last position. Box 713, AM. M.

Situation wanted by a designing draftsman several years' experience in Corliss steam engines, air compressors and rock drills; A-1 references. Box 707, AMERICAN MACHINIST.

Draftsman; age 29; technical graduate; practical experience as machinist and toolmaker; experienced in design of general machinery and structural work. Box 712, AMERICAN MACHINIST.

Position as superintendent or manager by first-class mechanic with large business and selling experience; salary $4000 up; governed by results; if you need a man let me look over your plant. "C. W.," AM. MACH.

Wanted—Responsible position where 16 years' steam engine, gas engine and other machinery designing, buying, selling, travelling and management experience can be used advantageously. Box 714, AMER. MACH.

OHIO

Foreman, 12 years' experience in chucking and screw machine department; accustomed to accurate work; can produce results; references. Box 700, AMERICAN MACH NIST.

Electrical engineer, designer, direct current motors and generators for all purposes; a practical mechanic, and familiar with every detail of manufacture; first-class references. Box 723, AMERICAN MACHINIST.

Master mechanic, colored man, age 45, with great inventive ability; has had 25 years' experience in erecting and maintaining air, steam and hydraulic machinery; will go to any part of the world; would like to hear from some large contracting or manufacturing company; best of references. Box 720, AMERICAN MACHINIST.

PENNSYLVANIA

Fourteen years tool room foreman; salary $1800; A-1 references. Box 716, AM. MACH.

Capable toolmaker; successful in inaugurating and carrying out a tool checking and caretaking system for large shop; refer to present employer. Box 715, AMER. MACH.

Practical machine shop engineer thoroughly familiar with steam and gas engines and all kinds of medium automatic machinery, desires position as plant engineer or designer of special machines and fixtures for reducing cost of production; at present superintendent of shops; best results insured; references A-1; salary $2400. Box 699, AM. M.

RHODE ISLAND

Reliable designer of special machinery, tools, jigs, fixtures, experimental work, steam turbines, knowledge of shop foundry, patterns; married; age 34. Box 708, AM. M.

Help Wanted

Classification indicates present address of advertiser, nothing else.

MASSACHUSETTS

Wanted—Foreman for tool department, competent to take charge of machine tool repairs, new tools and fixtures for economical production, and familiar with up to date shop products; factory located in New England with the best conditions. Box 704, AM. M.

MISSOURI

Wanted—One first-class machine blacksmith on job work who can get out work with steam hammer; steady work and good wages to a good sober man; open shop. Address Hugh Mathews, Kansas City, Mo.

NEW JERSEY

Wood patternmaker wanted; one familiar with agricultural work preferred; must be acquainted with small work. Box 719, AM. M.

NEW YORK

Designer, expert on all kinds of tool work, competent to take charge of designing and drafting department of 30 men. Write stating age, experience and salary expected to E. E. I., 41 West 34th Street.

Wanted—Mechanical engineer with extensive experience in designing presses and other machinery for sheet metals; applicants please state experience, etc. Niagara Machine and Tool Works, Buffalo, N. Y.

Toolmaker; A-1 practical mechanic experienced in the manufacturing of tools in all its branches and having experience in handling a large force of men; none but a man with such experience need apply; write stating age, experience and salary expected. "H. S. P.," 41 W. 34th St., New York.

OHIO

Top notch foundry superintendent wanted at once for new machine-molding gray iron foundry; the various buildings and equipment just being completed; strictly up-to-date including continuous pouring; applicant must be temperate in habits, of good character, aggressive, and above all, a good executive; full knowledge of molding machines and best application of patterns thereto absolutely necessary; give full particulars, references, where employed at present, and state salary required; all communications treated confidentially; no cheap man need apply. Address The Cincinnati Milling Machine Co., Cincinnati, Ohio.

PENNSYLVANIA

Wanted—A first-class mechanic and diemaker who wishes to get into business; I have a prosperous machine shop manufacturing business; foremanship position will be open. Benj. F. Bain, Pittsburg, Pa.

WEST VIRGINIA

Wanted—Several first-class machinists for marine engine work. The Charles Ward Engineering Works, Charleston, W. Va.

WISCONSIN

A first-class designer, with executive ability to take full charge of a shop employing from 30 to 50 men on small specialties; past accomplishments will be test of fitness; give references and salary expected. Box 702, AMERICAN MACHINIST.

FOREIGN

First-class machine tool fitters and turners leaving the States can apply to John Holroyd & Co., Ltd., near Rochdale, Lancashire, England, for situations.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Back copies American Machinist. J. Beasley, Metropolitan Bldg., Orange, N. J.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—Complete copies of American Machinist from date of its first publication, Nov., 1877, to the present time. Address J. W. Chamberlain, 443 East Market St., Akron, Ohio.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	98
Acme Machinery Co.	105
Adams Co.	64
Albro-Clem Elevator Co.	94
Almond Mfg. Co., T. R.	78
Alteneder & Son, Theo.	84
American Emery Wheel Wks.	98
American Gas Furnace Co.	21
American Pulley Co.	83
Amer. Tube & Stamping Co.	105
American School of Correspondence	99
American Tool Wks. Co.,	8 and 103
American Wood Working Mchy. Co.	71

PAGE

Armstrong-Blum Mfg. Co.... 76
Armstrong Bros. Tool Co.... 68
Artisan's Guild.....100
Athol Machine Co.....85
Automatic Machine Co.....74

Backus Water Motor Co.....84
Baker Bros. 77
Baldwin Chain & Mfg. Co...76
Baldwin Steel Co.....47
Bardons & Oliver 64
Barnes Co., B. F.....25
Barnes Co., W. F. & John...14
Barnett, G. & H.....36
Baush Machine Tool Co., 3d cover
Bay State Stamping Co.....80
Beaman & Smith.....15 and 78
Becker-Brainard Milling Machine Co.....23
Bemis & Call Hardware & Tool Co 70
Besly & Co., Chas. H.....100
Bethlehem Steel Co.....87
Betts Machine Co.....6
Bickford Drill & Tool Co....10
Bignall & Keeler Mfg. Co....75
Bilgram, Hugo.....94
Billings & Spencer Co.....66
Binsse Machine Co.....36
Birdsboro Steel Fdry. & Mach. Co. 69
Blaisdell Machinery Co.....88
Blanchard Machine Co.....70
Bliss Co, E. W.....25
Blount Co., J. G.....30
Boston Gear Wks.....94
Box & Co., Alfred.....82
Boynton & Plummer.....74
Bradford Machine Tool Co....1
Bradley & Son, C. C.....71
Bridgeport Safety Emery Wheel Co. 98
Bristol Co.....4th cover
Bristol, Wm. H.....36
Brown & Co., R. H.....79
Brown & Sharpe Mfg. Co., 45 and 4th cover
Brown Hoisting Mchry. Co..82
Brubaker & Bros., W. L.....75
Brunswick Refrigerating Co..70
Bullard Auto. Wrench Co....69
Bullard Mach. Tool Co.....35
Burke Electric Co.....92
Burke Machinery Co.....77
Burroughs Co., Chas.....70
Butterfield & Co.....80

C & C Electric Co.....90
Caldwell & Son Co., H. W...95
Cammel Laird & Co.....87
Carborundum Co.....9
Card Mfg. Co., S. W.....14
Carpenter Tap & Die Co., J. M.....72
Carver File Co.....80
Case Mfg. Co.....82
Cell Drier Machine Co.....101
Chambersburg Engineering Co. 71
Champion Tool Works.....75
Chicago Pneumatic Tool Co..89
Chicago Raw Hide Mfg. Co..95
Cincinnati Elec. Tool Co.....104
Cincinnati Lathe and Tool Co. 75
Cincinnati Machine Tool Co..68
Cincinnati Milling Machine Co. 7
Cincinnati Planer Co.....24
Cincinnati Shaper Co.....106
Clark Cast Steel Cement Co. 92
Clark Auto. Telephone Switchboard Co. 75
Clayton Air Compressor Wks. 92
Cleveland Auto. Mach. Co....18
Cleveland Cap Screw Co.....74
Cleveland Crane & Car Co...82
Cleveland Planer Works.....74
Cleveland Twist Drill Co., 4th cover
Cleveland Wire Spring Co...83
Clough, R. M.....95
Coates Clipper Mfg. Co.....72
Coes Wrench Co.....16
Colburn Machine Tool Co....101
Cook Co., Asa S.....76
Consolidated Press & Tool Co. 81
Crescent Forgings Co.....69

PAGE

Crocker-Wheeler Co..... 92
Crosby Steam Gage & Valve Co. 17
Curtis & Co. Mfg. Co..... 88
Curtis & Curtis Co.....101
Cushman Chuck Co..... 78

Davis Machine Co., W. P..... 61
Davis, Rodney..... 95
Desmond-Stephan Mfg. Co...101
Detrick & Harvey Mach. Co.. 75
Diamond Chain & Mfg. Co.. 76
Diamond Saw and Stamping Works 77
Dickinson, Thos. L..... 98
Dill Slotter People..... 30
Dixon Crucible Co., Jos..... 84
Dreses Machine Tool Co..... 5
Drucklieb, C..... 89

Earle Gear & Mach. Co..... 94
Eastern Machinery Co..... 74
Eberhardt Bros. Mach. Co... 94
Elmes Engineering Works, Chas. F..... 75
Errington, F. A..... 79
Evans Friction Cone Co.....100
Excelsior Needle Co..... 72

Farrel Fdry. & Machine Co.. 87
Fawcus Machine Co..... 94
Fay Machine Tool Co..... 21
Fellows Gear Shaper Co..... 57
Ferracute Machine Co..... 75
Firth-Sterling Steel Co..... 88
Fitchburg Machine Wks..... 29
Flather Planer Co., Mark ... 76
Foote-Burt Co., The..... 80
Fosdick Machine Tool Co.... 16
Franklin Mfg. Co., H. H..... 86
Franklin Port. Crane & Hoist Co. 82

Gang Co., Wm. E..... 76
Gardner Machine Co.....101
Gem Mfg. Co..... 81
General Electric Co..... 90
General Pneumatic Tool Co.. 83
Geometric Tool Co..... 21
Gisholt Machine Co.....105
Gleason Works.....4th cover
Globe Machine & Stamping Co. 76
Goldschmidt Thermit Co..... 87
Goodell-Pratt Co..... 80
Gorton Machine Co., Geo.... 70
Gould & Eberhardt..... 80
Graham Mfg. Co..... 85
Grant Gear Wks..... 94
Grant Mfg. and Machine Co. 81
Gray Co., G. A..... 20
Gray & Prior Machine Co., 72 and 81
Greaves, Klusman & Co..... 73
Gronkvist Drill Chuck Co... 78

Hammacher, Schlemmer Co.. 51
Hanna Engineering Wks.... 76
Hardinge Bros. 74
Harrison & Knight Mfg. Co.. 85
Harrington, Son & Co., Edw.. 83
Hart & Cooley Co..... 65
Hart Mfg. Co..... 81
Hebert Sales Co., J. R.....101
Hendey Machine Co..... 53
Henley Pub. Co., Norman W. 25
Henry & Wright Mfg. Co.... 65
Hill, Clarke & Co., Inc.....103
Hill Publishing Co....36 and 62
Hisey-Wolf Machine Co..... 25
Hoefer Mfg. Co..... 77
Hoggson & Pettis Mfg. Co... 78
Horsburgh & Scott Co..... 94
Horton & Son Co., E..... 78
Hunt Co., Robt. W..... 74
Hurlbut-Rogers Machine Co.. 75
Hyatt Roller Bearing Co.... 76

Industrial Oxygen Co..... 87
Ingersoll Milling Machine Co. 71
Ingersoll-Rand Co..... 89

Jacobs Mfg. Co..... 79
Jantz & Leist Elec. Co..... 92
Jenkins Bros. 84
Johnson Machine Co., Carlyle 57
Jones & Lamson Mach. Co., 12, 13 and 36
Juengst & Sons, George..... 68

PAGE

Kearney & Trecker..... 81
Kelly Co., R. A..... 73
Kempsmith Mfg. Co..... 22
Kern Machine Tool Co..... 63
Kilbourne & Jacobs Mfg. Co. 74

L. & D. Co..... 75
Landis Machine Co.....106
Landis Tool Co..... 47
Lapointe Machine Tool Co... 70
Lea Equipment Co..... 30
LeBlond Machine Tool Co., R. K.....4th cover
LeCount, Wm. G..... 79
Link Belt Co..... 93
Lodge & Shipley Machine Tool Co. 4
Long & Allstatter Co..... 73
Lucas Machine Tool Co.....104
Lumen Bearing Co..... 86
Lunkenheimer Co..... 84
Lyon Metallic Mfg. Co.....105

Manning, Maxwell & Moore, Inc .....96 and 97
Manufacturers Equipment and Engineering Co..... 72
Manville Bros. Co..... 17
Maris Bros..... 82
Marshall & Huschart Mch. Co. 103
Mass. Saw Works..... 80
McCabe, J. J.....64 and 102
Merritt, Jos..... 75
Merritt & Co..... 76
Metal Hardening Solution Co. 86
Milton Mfg. Co..... 51
Miner & Peck Mfg. Co..... 75
Monarch Emery & Cor. Wheel Co. 98
Moore Co., Franklin..... 82
Morse Chain Co..... 65
Morse Twist Drill & Mach. Co. 49
Morton Mfg. Co..... 74
Mossberg Wrench Co.....100
Motch & Merryweather Machine Co. 102
Mueller Mach. Tool Co..... 71
Mumford Co., E. H..... 76
Mummert, Wolf & Dixon Co. 76

Nash Co., Geo.....100
National Acme Mfg. Co.....106
National Machinery Co..... 75
New Britain Mach. Co..... 77
New Haven Mfg. Co..... 71
New Process Raw Hide Co... 95
Newton Machine Tool Wks.. 11
Nicholson File Co..... 17
Nicholson & Co., W. H..... 70
Niles-Bement-Pond Co., 2, 3, 32, 33 and 102
Nolte Brass Co..... 84
Northern Elec. Mfg. Co..... 91
Northern Engineering Works. 82
Norton Co. 59
Norton Grinding Co..... 28
Nuttall Co., R. D..... 94

Obermayer Co., S..... 87
O. K. Tool Holder Co..... 70
Olds Gas Power Co..... 84
Owen Mach. Tool Co..... 22

Parker Company, Chas..... 85
Patterson, Gottfried & Hunter, Ltd. 74
Pawling & Harnischfeger.... 82
Paxson Co., J. W..... 76
Philadelphia Bourse..... 71
Phosphor Bronze Smelting Co. 86
Philadelphia Gear Works.... 94
Pittsburg Auto. Vise & Tool Co. 85
Potter & Johnston Mach. Co. 53
Pratt Chuck Co..... 78
Pratt & Whitney Co...31 and 34
Prentice Bros. Co..... 27
Prentiss Tool & Supply Co., 102 and 103

Queen City Machine Tool Co. 75

Reed Co., F. E..... 67
Reed Mfg. Co..... 85
Reichhelm & Co., E. P..... 73
Ridgway Dynamo & Engine Co. 92

PAGE

Rivett-Dock Co.....3d cover
Rivett Lathe Mfg. Co...3d cover
Rock Island Tool Co..... 85
Rockwood Mfg. Co..... 82
Rogers & Hubbard Co..... 86
Rogers Wks., John M..... 72
Roth Bros. & Co..... 92
Rowell Co., W. G.....100
Royersford Fdry. & Mach. Co. 84

Safety Emery Wheel Co..... 98
Sampson Co., Geo. H..... 88
Saunders Co., James..... 69
Saunders Sons, D..... 72
Sawyer Gear Wks..... 94
Schieren & Co., Chas. A..... 77
Schmitz, August..... 73
Schreiber & Beuster.....101
Schumacher & Boye..... 9
Seaver, John W..... 72
Sebastian Lathe Co..... 63
Sellers & Co., Inc., Wm..... 26
Seneca Falls Mfg. Co..... 63
Shultz Belting Co..... 76
Sibley Mch. Tool Co..... 73
Skinner Chuck Co..... 78
Slate Machine Co., Dwight.. 71
Sloan & Chace Mfg. Co..... 59
Slocomb Co., J. T..... 81
Smith Countershaft Co..... 29
Smith & Mills..... 76
Smith & Post Co..... 77
Smith Co., Wm. J..... 5
Spacke Mach. Co., F. W..... 89
Sprague Electric Co..... 93
Springfield Mach. Tool Co... 15
Standard Connecting Rod Co. 80
Standard Engineering Works 74
Standard Gauge Steel Co....100
Standard Welding Co..... 66
Stark Tool Co..... 74
Starrett Co., L. S..... 67
Stoever Foundry & Mfg. Co.101
Straley & Hasbrouck..... 76
Struthers-Wells Co..... 84
Sturtevant Co., B. F..... 20

Tabor Mfg. Co..... 77
Tate, Jones & Co..... 63
Taylor & Fenn Co.....106
Taylor-Wilson Mfg. Co..... 94
Technical Supply Co..... 84
Toomey, Frank.....103
Triumph Electric Co..... 92
Trump Bros. Machine Co.... 79
Tudor Mfg. Co..... 81
Turner Brass Works..... 74

Union Twist Drill Co..... 55
Universal Machine Screw Co. 68
U. S. Electrical Tool Co..... 92

Van Dorn & Dutton..... 94
Vandyck Churchill Co..... 28
Vitrified Wheel Co..... 98
Von Wyck Mach. Tool Co.... 74

Walcott & Wood Mach. Tool Co. 95
Waltham Machine Works.... 75
Waltham Watch Tool Co....100
Ward & Sons, Edgar T. 86 and 87
Warner & Swasey Co.....104
Warner Instrument Co..... 73
Waterbury Barrel Fdry. & Mach. Co. 95
Watson-Stillman Co..... 65
Wells Bros. Co..... 64
Western Electric Co..... 90
West Haven Mfg. Co..... 75
Westmacott Gas Furnace Co. 74
Weston Elec. Instrument Co. 92
Whitcomb-Blaisdell Mach. Tool Co. 19
Whitman & Barnes Mfg. Co..103
Whitney Mfg. Co..... 43
Whiton Machine Co., D. E... 78
Wiley & Russell Mfg. Co....101
Williams & Co., J. H..... 75
Williamson Vise Co..... 85
Wilmarth & Morman Co..... 98
Wood's Sons Co., T. B..... 83
Woodward & Powell Planer Co. 106
Worcester Machine Screw Co. 74
Wormer Machinery Co., C. C.103

Classified Index to Articles Advertised

Abrasive Materials

Abrasive Material Co., Phila., Pa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.

Abrasive Materials—*Cont.*

Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Phila., Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.

Boring and Drilling Machines, Horizontal—*Cont.*

Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels.

Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Carr & Co., Stuart R., Baltimore, Md.
Cell Drier Machine Co., Taunton, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

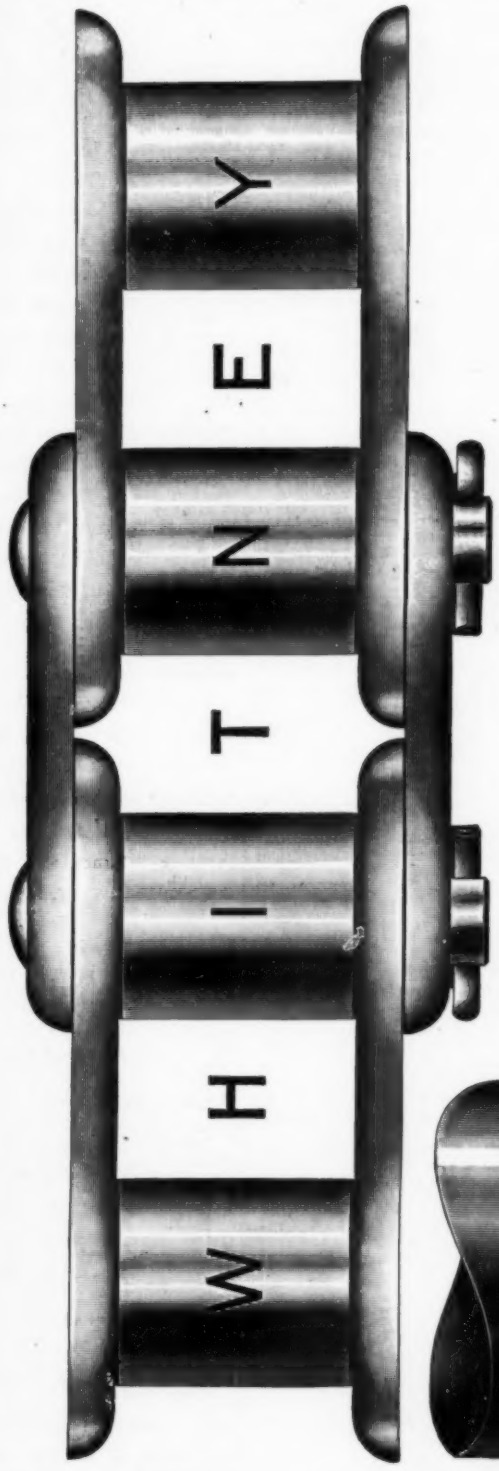
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

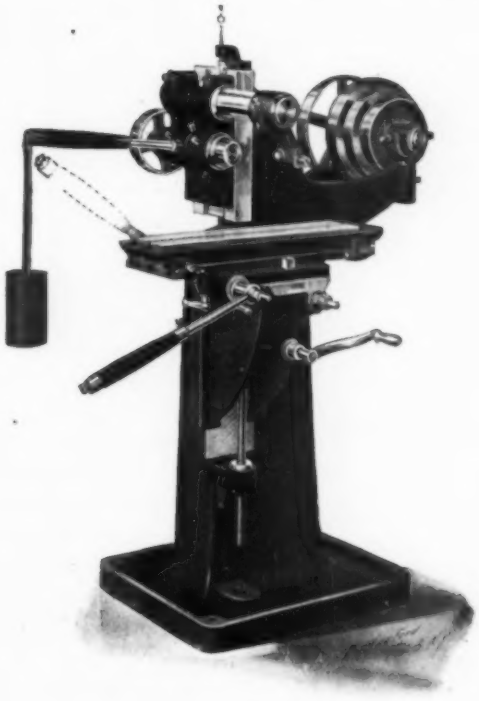
Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

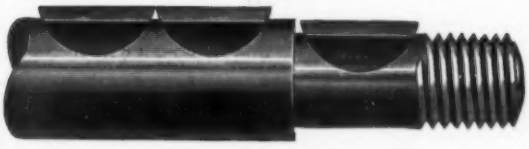
"WHITNEY" CHAINS

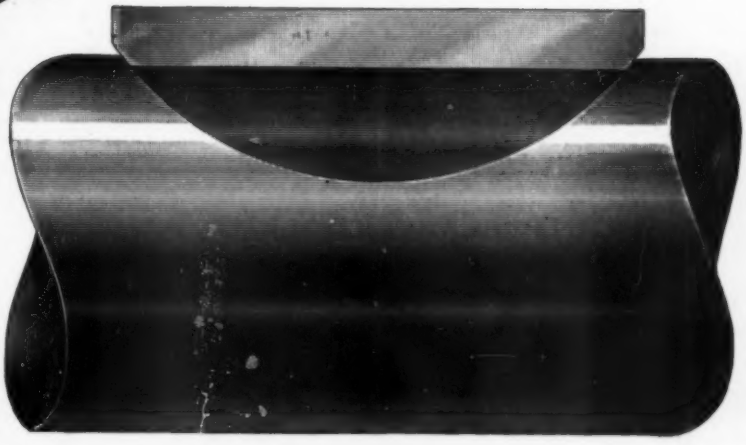
Hand (feed) Milling Machines
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Core

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Blaisdell Machinery Co., Bradford, Pa.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Cell Drier Machine Co., Taunton, Mass.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Hebert Sales Co., New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Manning, Maxwell & Moore, Inc., New York.
Mossberg Wrench Co., Central Falls, R. I.

Countershafts—*Continued.*

Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Crank Pin Turning Machines

Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Manning, Maxwell & Moore, Inc., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Manville Bros. Co., Waterbury, Conn.

Dies, Sub-Press

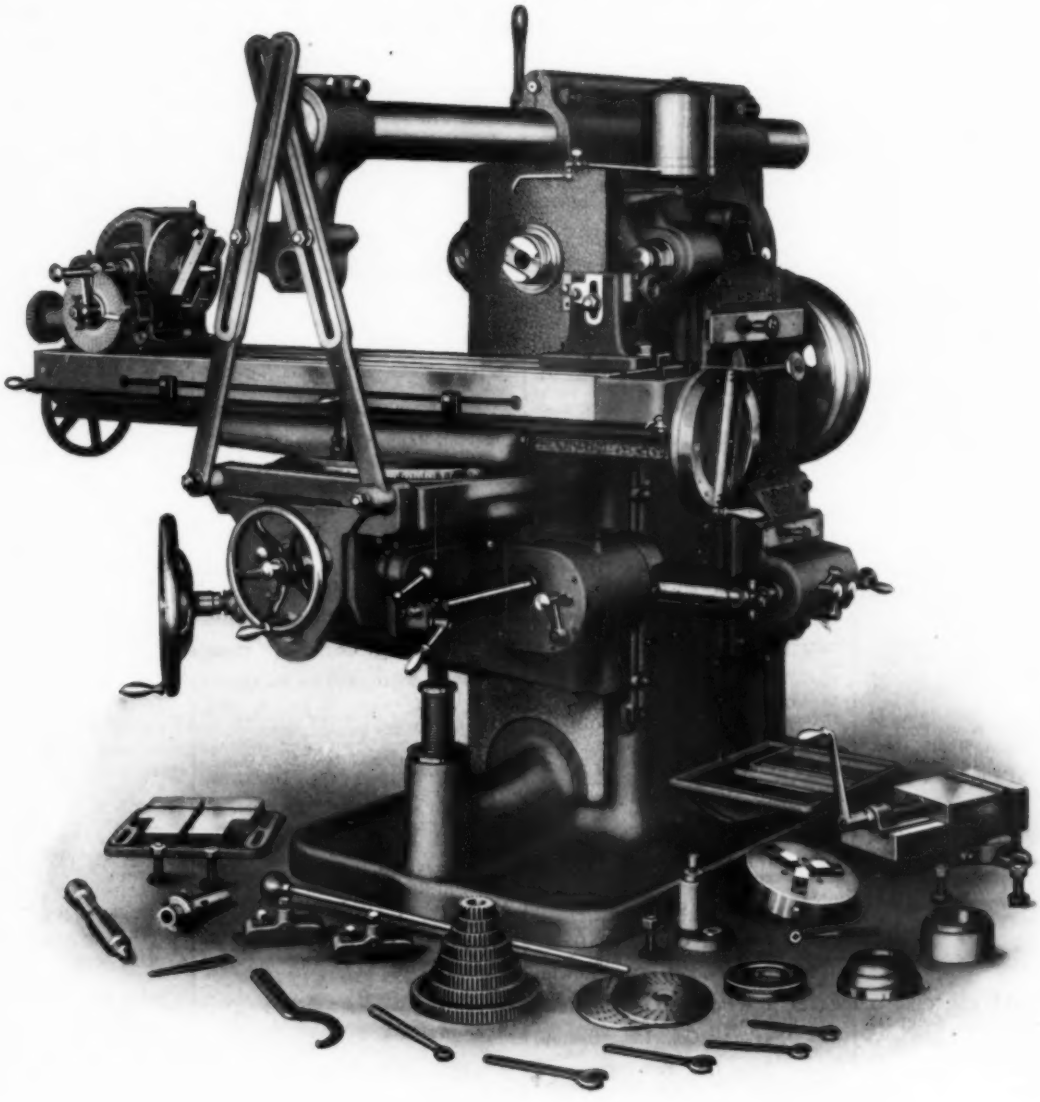
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Ideal Opening Die Co., New York.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.



No. 4—A Heavy Universal Milling Machine

with Constant Speed Drive.

Capacity:—

Longitudinal feed, 35". Transverse Feed 12".
Vertical feed, 20". Feeds automatic.

A machine with unusual power and rigidity which is well adapted to shops where heavy milling is done.

Special circular describing the machine in detail sent to any address upon application.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Artisans Guild, Benton Harbor, Mich.
Economy Drawing Table Co., Toledo, O.
Kolesch & Co., New York.
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Smith, M. A., Providence, R. I.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boylton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Andrews & Co., M. L., Cincinnati, Ohio.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Cincinnati Pulley Machry. Co., Cincinnati, Ohio.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Drilling Machines, Upright —*Continued.*
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.

Drills, Rail
Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Manning, Maxwell & Moore, Inc., New York.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.

Electrical Supplies —*Continued.*
Western Electric Co., Chicago, Ill.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Manning, Maxwell & Moore, Inc., New York.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker - Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Jackson, Henry Docker, Boston, Mass.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

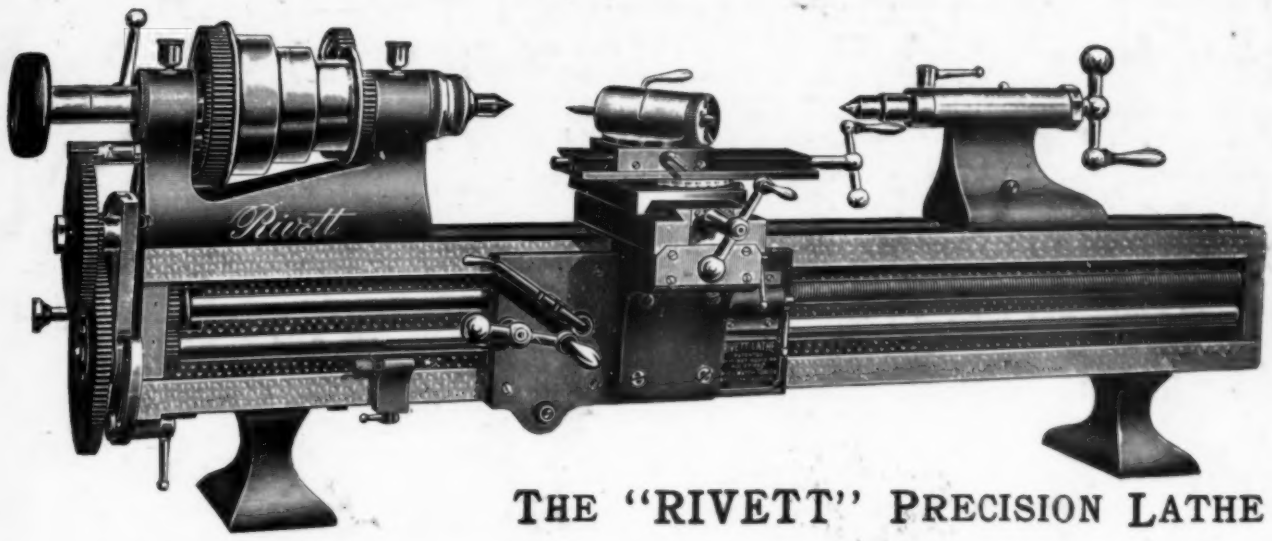
Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

FOR FINE ACCURATE LATHE WORK



THE "RIVETT" PRECISION LATHE

is especially designed; it is built by high grade workmen, with the best materials; has full adjustments on all movements; the sliding surfaces are accurately scraped and all bearings truly ground; the lead screw is as perfect as it can possibly be made and is of large diameter, to avoid torsional effects.

Catalog containing valuable data, tables, etc., for small toolmakers on request. **The Rivett Lathe Mfg. Co.,** Brighton, Boston, Mass.

For your Threaded Work, ask for Catalog. **The Rivett-Dock Co.,** Brighton, Boston, Mass.

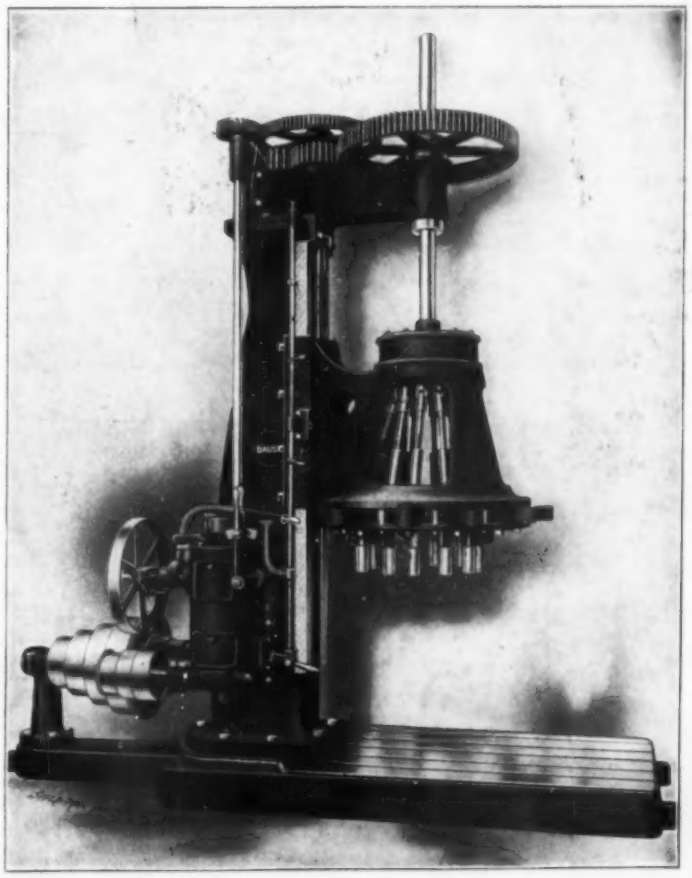
What do you Know about this?

Baush Adjustable Multiple Spindle Drills make two or more holes, on the same side of a piece of work and at the same angle, simultaneously. They cover all sizes of layouts up to 46" diameter and all shapes, and by their fast, multiple work cut cost of production in two easily. The saving in time and labor is enormous.

Don't you need such a drill in your shop? Ask for BULLETINS.

Cut shows our No. 24, carrying 12 spindles.

We also build Rapid Production Boring Mills and Radial Drills.



Baush Machine Tool Co.,

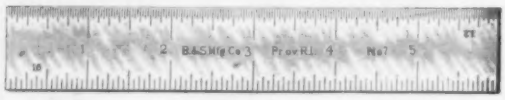
640 Wason Avenue,

SPRINGFIELD, MASS., U. S. A.

AGENTS—Manning, Maxwell & Moore, New York, Chicago, Philadelphia, Boston, Cleveland, Pittsburg, St. Louis, Detroit, Syracuse and Birmingham. DeFries & Cie, Akt. Ges. Dusseldorf, Berlin and Milan. Selig, Sonnenthal & Co., London. Hugo Tulquists, Stockholm. Alfred H. Schutte, Brussels. Takata & Co., Japan.

Brown & Sharpe Mfg. Co.,
PROVIDENCE, R. I., U. S. A.

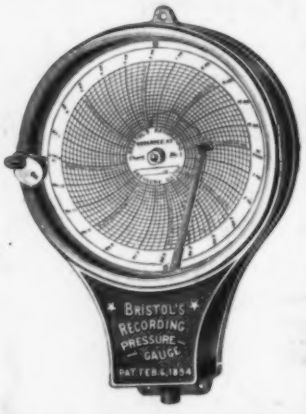
We have an Accurate Rule in stock for almost any need that may arise.



The small tool catalogue sent on application, describes them.

We manufacture eight sizes of Plain and six sizes of
Universal Milling Machines
They are modern and up-to-date.
Send for Catalog.
The R. K. Le Blond Machine Tool Company,
4620 Eastern Ave. Cincinnati, Ohio.

SAFETY
IS ESSENTIAL AND
ECONOMY
IS DESIRABLE IN
EVERY INDUSTRY.
SEND FOR CATALOG D-1
AND LET US TELL YOU HOW
BOTH ARE SECURED
IN THE USE OF
BRISTOL'S
RECORDING GAUGES
ALL RANGES
THE BRISTOL CO.,
Waterbury, Conn.
New York, Chicago.
London, 23 College Hill.

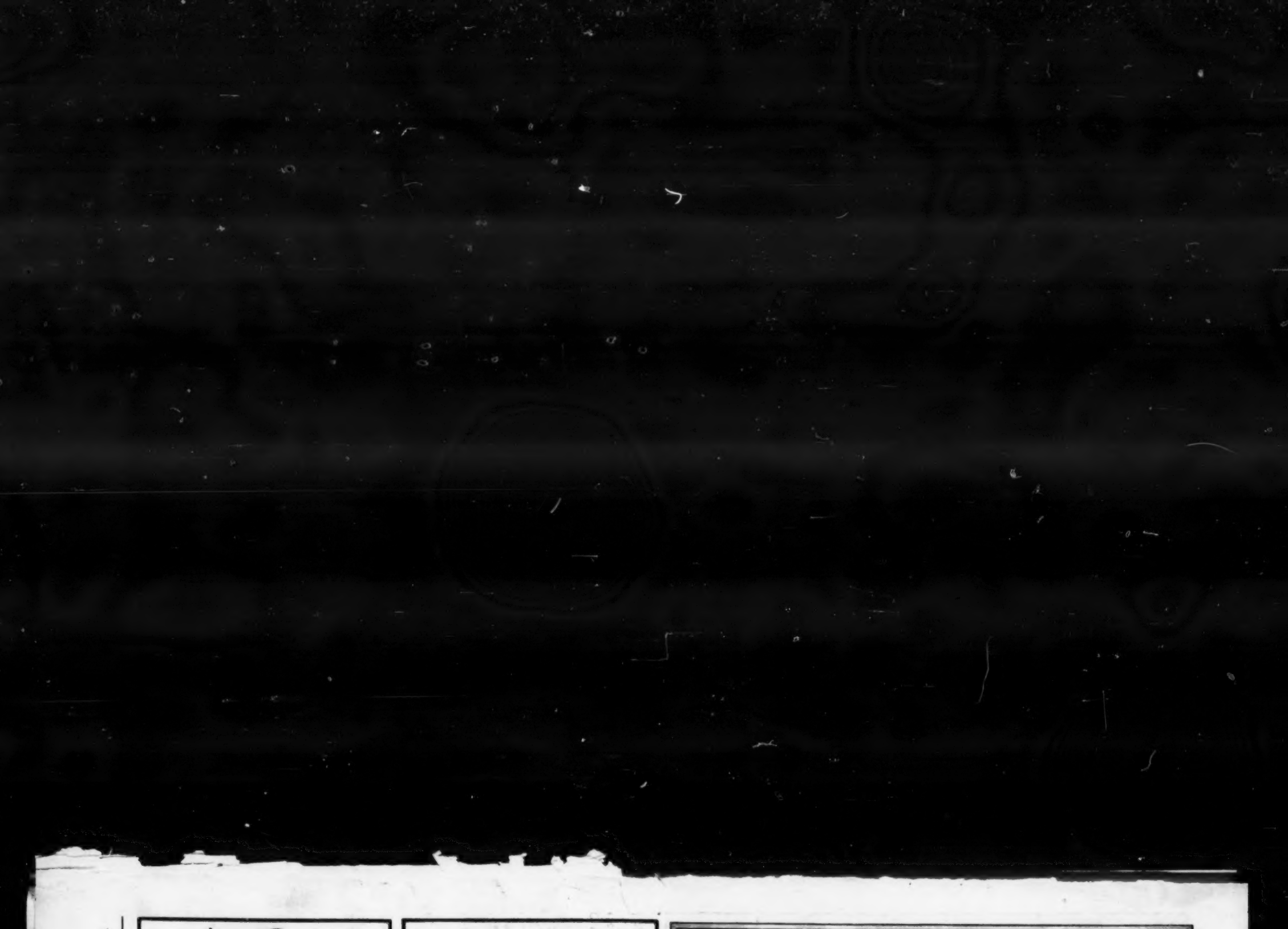


CLEVELAND

DRILLS
REAMERS
SOCKETS
BITS
·ETC·
CATALOGS UPON REQUEST

"PEERLESS" HIGH SPEED STEEL REAMERS
ALL THAT THEIR NAME IMPLIES

This is the "Peerless" Taper Shank Core Reamer. The blades being of **High Speed Steel** and the body special tough stock, permits rapid cutting to the full capacity of the blades. If you want cored or punched holes enlarged, you will find this style of tool especially economical. Also made in the Expansion Type with either straight or taper shanks. :: Write for Catalog 35, it tells more of the "PEERLESS" Reamers.

STAYBOLT
TAPS
CUTTERS
MILLS
COUNTER-BORES
·ETC·
SPECIAL TOOLS TO ORDER

THE CLEVELAND TWIST DRILL CO.
NEW YORK 62 READE STREET. CLEVELAND, OHIO, U.S.A. CHICAGO 46 SOUTH CANAL STREET.